Foreword

The Soil Survey of Malheur, Oregon, Northeastern Part, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

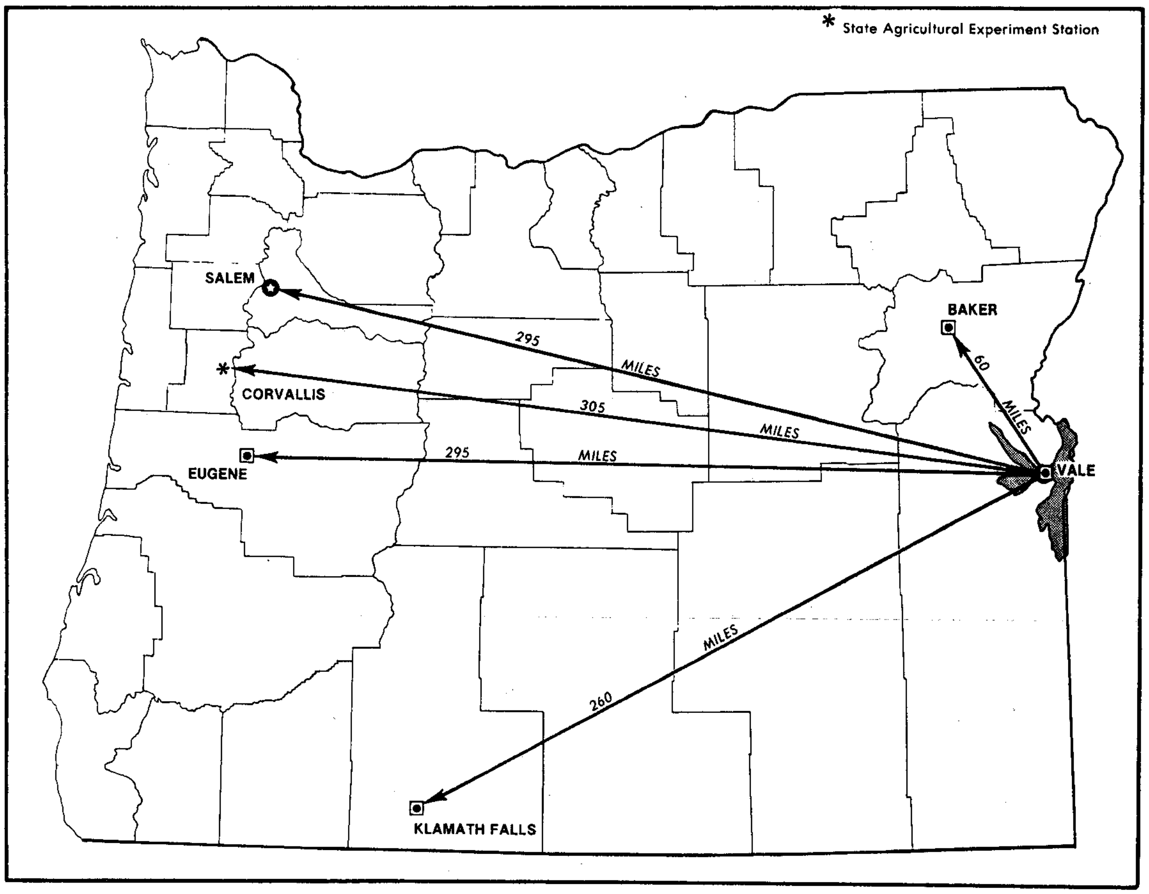
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or. roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground-installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

State Conservationist
Soil Conservation Service



Location of Malheur County, Northeastern Part, in Oregon.

SOIL SURVEY OF MALHEUR COUNTY, OREGON NORTHEASTERN PART

By Burrell B. Lovell, Soil Conservation Service

Fieldwork by Burrell B. Lovell, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Oregon Agricultural Experiment Station

MALHEUR COUNTY, NORTHEASTERN PART, is in extreme eastern Oregon (see map on facing page). This area is the main concentrated block of irrigated farmland in the county and contains the major towns of the county. Vale, the county seat, has a population of about 1,750, Ontario has 7,742, Nyssa has 2,900, and Adrian has about 170. The survey area covers 226,00 acres, or 353 square miles.

The survey area is in the Snake River Plains Resource Area. The eastern edge borders the Snake River. The Malheur and Owyhee Rivers both cross the survey area and join the Snake River within the area. All of these rivers furnish irrigation water. The Vale-Oregon and Warm Springs projects have dams and storage on the Malheur River and its tributaries. The Owyhee Project has a large concrete arch structure on the Owyhee River and supplies water to a major portion of the land. Snake River water is pumped to where it can be used. The area surveyed lies below the main irrigation canals and is on old lake terraces and alluvial valley fill. Elevation ranges from about 2,100 feet along the Snake River at Weiser Annex to about 2,600 feet where the Owyhee main canal starts in the Mitchell Butte area in the southern part.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classed and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Descriptions of the soils."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information, available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Descriptions of soil map units

1. Powder-Turbyfill-Garbutt

Deep silt loams and fine-sandy loams

This map unit consists of smooth, nearly level soils on bottom lands and fans. These soils formed in recent alluvium. The native vegetation was needlegrass, bluebunch wheatgrass, big sagebrush, rabbitbrush, and forbs. Elevation ranges from 2,100 to 2,600 feet. Average annual precipitation ranges from 8 to 11 inches, and average annual air temperature ranges from 45 degrees to 53 degrees F. The frost-free period is 120 to 170 days.

This map unit makes up about 16 percent of the survey area. It is about 35 percent Powder soils, 20 percent Turbyfill soils, and 20 percent Garbutt soils. Umapine, Stanfield, Poden, and Kimberly soils and Riverwash make up about 25 percent.

Powder soils are on stream bottoms and are well drained. They have a surface layer and subsoil of grayish brown silt loam. Depth to bedrock is 60 inches or more.

Turbyfill soils are on stream bottoms and fans and are well drained. They have a surface layer of pale brown fine sandy loam. The underlying material is pale brown and very pale brown fine sandy loam. Depth to bedrock is 60 inches or more.

Garbutt soils are on stream bottoms and fans and are well drained. They have a surface layer of very pale brown silt loam. The underlying material is pale brown and very pale

The soils are well suited to sugar beets, potatoes, onions, field corn, sweet corn, small grain, alfalfa seed, vegetable seed, hay, and wildlife habitat. The wildlife is mainly upland birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is very limited and occurs mainly in spring when the soil is frozen beneath the surface. Erosion by runoff is minor, but erosive heads of irrigation water can increase sediment removal and cut vertical banks in the field.

2. Umapine-Stanfield

Very strongly alkali silt loams; some are deep and some are moderately deep over a hardpan

This map unit consists of smooth, nearly level soils on bottom lands. These soils formed in old alluvium. The native vegetation was saltgrass, giant wildrye, and greasewood. Elevation ranges from 2,100 to 2,600 feet. Average annual precipitation ranges from 9 to 11 inches, and the average annual air temperature ranges from 48 degrees to 54 degrees F. The frost-free period is 110 to 170 days.

This map unit makes up about 17 percent of the survey area. It is about 60 percent Umapine soils and 20 percent Stanfield soils. Otoole, Poden, Powder, and Ahtanum soils make up about 20 percent.

Umapine soils are on stream bottoms and low terraces and are somewhat poorly drained. They are deep silt loam and are very strongly alkaline to strongly alkaline in the upper part. A white salt crust forms on the surface during part of the year. Depth to bedrock is more than 60 inches.

Stanfield soils are on stream bottoms and low terraces and are moderately well drained. They are moderately deep silt loam over a silica-cemented hardpan. They are very strongly alkaline throughout. A white salt crust forms on the surface during part of the year. Depth to the hardpan is 20 to 40 inches. Depth to bedrock is more than 60 inches.

If adequately drained, the soils are suited to pasture, some small grain, hay, and wildlife habitat. The wildlife is mainly upland game birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is very limited and occurs mainly in spring when the soil is frozen beneath the surface. Erosion by runoff is minor.

3. Feltham-Cencove-Quincy

Deep loamy fine sands and fine sandy loams that are moderately deep over gravel and sand

This map unit consists of smooth, rolling soils on terrace tops and old dune areas adjacent to the Snake River. These soils formed in eolian and wind-modified alluvial material over old lacustrine material. The native vegetation was needlegrass, Indian ricegrass, rabbitbrush, and big sagebrush. Elevation ranges from 2,100 to 2,600 feet.

Average annual precipitation ranges from 8 to 11 inches, and average annual air temperature ranges from 50 degrees to 53 degrees F. The frost-free period is 150 to 180 days.

This map unit makes up about 3 percent of the survey area. It is about 35 percent Feltham soils, 25 percent Cencove soils, and 20 percent Quincy soils. Sagehill, Truesdale, Nyssa gravel substratum, and Mesel soils make up about 20 percent.

Feltham soils are on terraces and alluvial fans and are excessively drained. They have a surface layer of brown loamy fine sand. The underlying material is brown and pale brown loamy fine sand and fine sandy loam. Depth to bedrock is more than 60 inches.

Cencove soils are on terraces and are well drained. They have a surface layer of pale brown fine sandy loam. The underlying material is brown fine sandy loam to a depth of 20 to 40 inches, and below that it is very gravelly sand. Depth to bedrock is more than 60 inches.

Quincy soils are on terraces and are excessively drained. They have a surface layer of dark brown loamy fine sand. The underlying material is brown loamy fine sand. Depth to bedrock is more than 60 inches.

The soils are suited to potatoes, onions, field corn, sweet corn, small grain, seed production, alfalfa hay, and wildlife habitat. The wildlife is mainly upland game birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is slow. Soil blowing occurs in spring when the soils are dry and bare.

4. Owyhee-Greenleaf

Deep silt loams

This map unit consists of smooth, rolling soils on terraces. These soils formed in loess-capped old lacustrine sediment. The native vegetation was needlegrass, bluebunch wheatgrass, big sagebrush, and rabbitbrush. Elevation ranges from 2,100 to 2,500 feet. Average annual precipitation ranges from 8 to 10 inches, and average annual air temperature ranges from 50 degrees to 52 degrees F. The frost-free period is 150 to 180 days.

This map unit makes up about 16 percent of the survey area. It is about 60 percent Owyhee soils and 20 percent Greenleaf soils. Nyssa, Malheur, Sagehill, and Truesdale soils and Xeric Torriorthents make up about 20 percent.

Owyhee soils are on medium terraces and are well drained. They have a surface layer of pale brown silt loam. The upper part of the substratum is white silt loam, and the lower part is light gray, laminated silt loam and very fine sandy loam. Depth to bedrock is more than 60 inches.

Greenleaf soils are on low terraces and are well drained. They have a surface layer of light brownish gray silt loam. The subsoil is brown silty clay loam, and the substratum is very pale brown and light gray, laminated silt loam. Depth to bedrock is more than 60 inches.

Where slope is favorable, the soils are well suited to sugar beets, potatoes, onions, field corn, sweet corn, small grain, alfalfa seed, vegetable seed, alfalfa hay, and wildlife habitat. The wildlife is mainly upland game birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the steeper Owyhee soils. Erosion by runoff is low to moderate. Using soil- and water-conserving practices on steeper slopes minimizes the hazard of erosion.

5. Nyssa-Virtue

Silt loams that are moderately deep over a hardpan

This map unit consists of smooth, rolling soils on high terraces. These soils formed in loess-capped old lacustrine and alluvial sediments. The native vegetation was needlegrass, bluebunch wheatgrass, rabbitbrush, and big sagebrush. Elevation ranges from 2,100 to 2,600 feet. Average annual precipitation ranges from 9 to 11 inches, and average annual air temperature ranges from 48 degrees to 54 degrees F. The frost-free period is 110 to 170 days.

This map unit makes up about 30 percent of the survey area. It is about 55 percent Nyssa soils and 20 percent Virtue soils. Owyhee, Truesdale, Frohman, Malheur, and Chilcott soils and Xeric Torriorthents make up about 25 percent.

Nyssa soils are on terraces and are well drained. They have a surface layer of light brownish gray silt loam. The subsoil is pale brown silt loam over a calcium- and silica-cemented hardpan. Depth to the hardpan is 20 to 40 inches. Depth to bedrock is more than 60 inches.

Virtue soils are on high terraces and are well drained. They have a surface layer of light brownish gray and pale brown silt loam. The subsoil is yellowish brown silty clay loam over a calcium- and silica-cemented hardpan. Depth to the hardpan is 20 to 40 inches. Depth to bedrock is more than 60 inches.

Where slope is favorable, the soils are suited to sugar beets, potatoes, onions, field corn, small grain, alfalfa seed, alfalfa hay, and wildlife habitat. The wildlife is mainly upland game birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the steeper slopes. Erosion by runoff is low to moderate. Using soil- and water-conserving practices on steeper slopes minimizes the hazard of erosion.

6. Frohman-Virtue

Silt loams that are shallow and moderately deep over a hardpan

This map unit consists of smooth, rolling soils on terraces. These soils formed in loess-capped old lacustrine and alluvial sediment. The native vegetation was Sandberg bluegrass, bluebunch wheatgrass, rabbitbrush, and big sagebrush. Elevation ranges from 2,100 to 2,600 feet.

Average annual precipitation ranges from 9 to 11 inches, and average annual air temperature ranges from 48 degrees to 54 degrees F. The frost-free period is 110 to 170 days.

This map unit makes up about 18 percent of the survey area. It is about 60 percent Frohman soils and 20 percent Virtue soils. Nyssa, Truesdale, Malheur, and Chilcott soils and Xeric Torriorthents make up about 20 percent.

Frohman soils are on terraces and are well drained. They have a surface layer and subsoil of light brownish gray silt loam over a silica-cemented hardpan. Depth to the hardpan is 10 to 20 inches. Depth to bedrock is 60 inches or more.

Virtue soils are on high terraces and are well drained. They have a surface layer of light brownish gray silt loam. The subsoil is yellowish brown silty clay loam over a calcium- and silica-cemented hardpan. Depth to bedrock is more than 60 inches.

Where slope is favorable, the soils are suited to small grain, alfalfa seed, alfalfa hay, occasionally sugar beets, potatoes, and wildlife habitat. The wildlife is mainly upland game birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the steeper slopes. Erosion by runoff is moderate to high. Using soil- and water-conserving practices on steeper slopes minimizes the hazard of erosion.

Descriptions of the soils

This section describes each soil series in detail and each map unit in that series briefly. Unless stated otherwise, what is stated about the soil series holds true for the map units in that series. Thus, to get full information about any one map unit, it is necessary to read both the description of the map unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, the sequence of layers from the surface down to rock or other underlying material. Each series contains two descriptions of the profile. The first is brief and in terms familiar to a layman. The second is more detailed and is included for those who need to make thorough and precise studies of soils. The profile described in the series is representative for map units in that series. If the profile of a given map unit differs from the one described for the series, these differences are stated in describing the map unit, or they are differences that are apparent in the name of the map unit. Color terms are for dry soil unless otherwise stated.

Soils that have a profile that is almost alike make up a *soil series.* Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Cencove fine sandy loam, 8 to 12 percent slopes, is one of several phases within the Cencove series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Nyssa-Malheur silt loams, 0 to 5 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas;* they are delineated on the soil map and given descriptive names. Duneland is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

Preceding the name of each map unit is a symbol that identifies the map unit on the detailed soil map. At the end of each description of a map unit the capability unit in which the map unit has been placed is given.

The acreage and proportionate extent of each map unit are given in table 1, and additional information on properties, limitations,. capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary, and more detailed information about the terminology and methods of soil mapping can be found in the Soil Survey Manual (6).

Ahtanum series

The Ahtanum series consists of somewhat poorly drained soils that formed on flood plains and low fans in medium textured mixed alluvium. Slopes are 0 to 2 percent. Elevation is 2,200 to 2,600 feet. The native vegetation was saltgrass, giant wildrye, and greasewood. Average annual precipitation is 8 to 10 inches, average annual air temperature is 48 degrees to 52 degrees F, and the frost-free period is 110 to 150 days.

In a representative profile, the surface layer is grayish brown silt loam about 10 inches thick. The underlying material is grayish brown silt loam to a depth of 30 inches. Below this is a grayish brown, silica-cemented hardpan. The soil is moderately alkaline throughout.

Permeability is moderate above the hardpan and slow to very slow in the hardpan. Available water capacity is 4 to 6 inches. Effective rooting depth is 20 to 40 inches. A seasonal water table is at a depth of 1 to 2 feet during the irrigation period. Rare flooding occurs during spring runoff.

These soils are used for irrigated pasture, hay, occasional row crops, and wildlife habitat.

Representative profile of the Ahtanum silt loam about 100 feet north of a barn, 20 feet east of a north-south fence in SW1/4SW1/4SW1/4 section 30, T. 16 S., R. 44 E.:

Ap-0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; many fine roots; many fine tubular pores; moderately alkaline; abrupt smooth boundary.

A12-6 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; many fine roots; many fine tubular pores; moderately alkaline; abrupt smooth boundary.

C1-10 to 23 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; moderately calcareous; moderately alkaline; gradual wavy boundary.

C2-23 to 30 inches; grayish brown (10YR 5/2) silt loam, dark brown (10YR 3/3) moist; weak very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; 20 percent durinodes 1/2 inch diameter; moderately alkaline; abrupt wavy boundary.

Ccasim-30 to 32 inches; grayish brown (10YR 5/2) silica-cemented dunpan of silty material, very dark brown (10YR 2/2) moist; massive; strongly cemented; very hard, very funny nonsticky and nonplastic; very few roots; very few tubular pores; strong effervescence; abrupt wavy boundary.

The A horizon is silt loam that is more than 18 percent clay. It is moderately to strongly alkaline and high in sodium. The lower part of the C horizon contains 5 to 30 percent weakly silica-cemented durinodes 1/4 to 1/2 inch in diameter. Depth to the silicacemented duripan ranges from 20 to 40 inches but is generally less than 30 inches. The duripan may have a root mat on the upper surface.

1-Ahtanum silt loam. This soil is in irregularly shaped areas on low fans and flood plains. Slope are 0 to 2 percent.

Included with this soil in mapping were about 10 percent Harana soils. Also included were about 10 percent soils that are similar to Ahtanum soils but that are 10 to 20 inches deep to the hardpan.

Runoff is slow, and the hazard of erosion is slight. Capability unit IVw-1.

Baldock series

The Baldock series consists of somewhat poorly drained soils that formed on low terraces, fans, and bottom lands in medium textured alluvium. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was saltgrass, giant wildrye, rabbitbrush, greasewood, and big sagebrush. Average annual precipitation is 9 to 11 inches, average annual air temperature is 48 degrees to 52 degrees F, and the frost-free period is 120 to 160 days.

In a representative profile, the surface layer is light brownish gray silt loam about 16 inches thick. The subsoil is grayish brown silt loam about 16 inches thick The substratum is light gray silt loam to a depth of 60 inches or more. The soil is strongly alkaline above a depth of about 32 inches and very strongly alkaline below a depth of 32 inches.

Permeability is moderate to moderately slow. Available water capacity is 8 to 10 inches. Effective rooting depth is 60 inches or more. A seasonal water table is at a depth of 2 to 3 feet during the irrigation period. Rare flooding occurs during spring runoff.

These soils are used for irrigated pasture, hay, small grain, sugar beets, and wildlife habitat.

Representative profile of Baldock silt loam about 850 feet east of section corner in the SEl/4SW1/4SW1/4 section 21, T. 17 S., R. 47 E.:

Ap-0 to 9 inches; light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium to fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many fine irregular pores; moderately calcareous; strongly alkaline; abrupt smooth boundary.

A1-9 to 16 inches; light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few tine roots; many fine irregular pores; moderately calcareous; strongly alkaline; gradual wavy boundary.

B2-16 to 32 inches; grayish brown (10YR 5/2) silt loam; very dark gray (10YR 3/1) moist; few faint yellowish brown (10YR 5/4) mottles, dark brown (10YR 3/3) moist; moderate fine angular blocky structure; hard, firm, sticky and plastic; few fine roots; many fine tubular pores; moderately calcareous; strongly alkaline; gradual wavy boundary.

Cca-32 to 60 inches; light gray (10YR 7/2) silt loam, brown to dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; very few fine roots; few fine tubular pores; strongly calcareous; very strongly alkaline.

The A horizon is light brownish gray or light gray loam or silt loam. It is more than 18 percent clay. It is calcareous and moderately alkaline to strongly alkaline. The 10- to 40-inch control section is loam or silt loam

2-Baldock silt loam. This soil is in irregularly shaped areas on stream bottoms, alluvial fans, and low terraces.

Included with this soil in mapping were about 10 percent Umapine soils and about 5 percent Stanfield soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIw-1.

Bully series

The Bully series consists of well drained soils that formed on bottom lands and fans in mixed alluvium that is high in diatomaceous material. Slopes are 0 to 2 percent. Elevation is 2,500 to 2,700 feet. The native vegetation was giant wildrye, bluebunch wheatgrass, hopsage, and big sagebrush. Average annual precipitation is 7 to 9 inches, average annual air temperature is 48 degrees to 50 degrees F, and the frost-free period is 120 to 150 days.

In a representative profile, the surface layer is light gray silt loam about 9 inches thick. The underlying material is light gray silt loam to a depth of 60 inches or more. The soil is mildly alkaline above a depth of 9 inches and moderately alkaline below that depth.

Permeability is moderate. Available water capacity is 10 to 12.5 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated corn, potatoes, onions, small grain, alfalfa hay, pasture, and wildlife habitat.

Representative profile of Bully silt loam about 1/2 mile northwest of Harper, 40 feet north and 40 feet east of the southwest corner of the SE1/4 section 31, T. 19 S., R. 42 E.:

Ap-0 to 9 inches; light gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; few roots; many fine round pores; mildly alkaline; abrupt smooth boundary.

C1-9 to 30 inches; light gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; few roots; common fine tubular pores; few white soft diatomite fragments; noncalcareous; moderately alkaline; diffuse wavy boundary.

C2-30 to 60 inches; light gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; few roots; few fine tubular pores; few soft diatomite fragments in the matrix, increasing with depth; few thin lenses of very fine sandy loam; noncalcareous; moderately alkaline.

The A and C horizons are silt loam, loam, or very fine sandy loam. Silica-cemented durinodes as large as 1/2 inch in diameter make up 2 to 10 percent of the C horizon.

3-Bully silt loam. This soil is in irregularly shaped areas on flood plains and fans.

Included with this soil in mapping were about 10 percent Powder soils, about 5 percent Umapine soils, and about 5 percent Stanfield soils.

Runoff is slow. The hazard of erosion is severe because of the light weight of the soil, its tendency to undercut in corrugations and furrows, and gullies. Capability unit IIe-1.

Cencove series

The Cencove series consists of well drained soils that formed on medium and low terraces in mixed alluvium. Slopes are 0 to 12 percent. Elevation is 2,200 to 2,500 feet. The native vegetation was Sandberg bluegrass, bluebunch wheatgrass, and big sagebrush. Average annual precipitation is 9 to 11 inches, average annual sir temperature is 50 degrees to 52 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is pale brown fine sandy loam about 9 inches thick. The upper part of the underlying material, to a depth of 24 inches, is brown fine sandy loam, and the lower part is very gravelly sand to a depth of 60 inches or more. The soil is mildly alkaline above a depth of about 9 inches and moderately alkaline below that depth.

Permeability is moderately rapid in the upper part and very rapid in the very gravelly sand. Available water capacity is 4 to 6 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for irrigated potatoes, onions, corn, sugar beets, small grain, alfalfa seed, alfalfa hay, pasture, and wildlife habitat.

Representative profile of Cencove fine sandy loam, 0 to 2 percent slopes, about 1,320 feet north and 750 feet east of the country road, SWl/4SE1/4 section 25, T. 16 S., R. 47 E.:

Ap-0 to 9 inches; pale brown (10YR 6/3) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; many fine irregular pores; mildly alkaline; abrupt smooth boundary.

C1ca-9 to 16 inches; brown (10YR 5/3) fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; very friable, slightly hard, nonsticky and slightly plastic; many fine roots; few fine tubular pores; weakly calcareous; moderately alkaline; gradual wavy boundary.

C2ca-16 to 24 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; very friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; moderately calcareous; moderately alkaline; abrupt wavy boundary.

IIC3-24 to 60 inches; multicolored very gravelly sand; single grained; loose; weakly calcareous; gravel coated with lime on lower side; moderately alkaline.

The A horizon has a value of 5 or 6 when dry and a chroma of 2 or 3 when dry or moist. It is sandy loam or fine sandy loam The Cl and C2 horizons have a value of 5 or 6 when dry and a chroma of 2 or 3 when dry or moist. They are fine sandy loam or sandy loam. Depth to the very gravelly sand IIC horizon ranges from 20 to 40 inches.

4A-Cencove fine sandy loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were about 5 percent Nyssa soils, gravel substratum; about 5 percent Nyssa soils; about 5 percent Sagehill soils; and about 5 percent Truesdale soils.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Capability unit IIIs-5.

4B-Cencove fine sandy loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas.

Included with this soil in mapping were about 5 percent Nyssa soils, gravel substratum; about 5 percent Nyssa soils; about 5 percent Sagehill soils; and about 5 percent Truesdale soils.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Capability unit IIIe-3.

4C-Cencove fine sandy loam, 5 to 8 percent slopes. This soil is in irregularly shaped areas.

Included with this soil in mapping were about 5 percent Nyssa soils, gravel substratum; about 5 percent Nyssa soils; and about 5 percent Truesdale soils.

Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Capability unit IIIe-3.

4D-Cencove fine sandy loam, 8 to 12 percent slopes. This soil is in irregularly shaped areas.

Included with this soil in mapping were about 5 percent Nyssa soils, gravel substratum; about 5 percent Nyssa soils; and about 5 percent Truesdale soils.

Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Capability unit IVe-2.

Chilcott series

The Chilcott series consists of well drained soils that formed on undulating high terraces in medium textured material over a cemented hardpan. Slopes are 2 to 12 percent. Elevation is 2,500 to 2,600 feet. The native vegetation was bluebunch wheatgrass, Sandberg bluegrass, cheatgrass, and big sagebrush. Average annual precipitation is 8 to 11 inches, average annual air temperature is 47 degrees to 52 degrees F, and the frost-free period is 125 to 170 days.

In a representative profile, the surface layer is pale brown silt loam about 13 inches thick. The upper 5 inches of the subsoil is brown silty clay, and the lower 9 inches is yellowish brown silty clay loam. The substratum is mainly light gray silty clay loam to a depth of 37 inches. A silica-cemented hardpan is at a depth of about 37 inches. The soil is moderately alkaline above a depth of 30 inches and strongly alkaline between depths of 30 and 37 inches.

Permeability is slow in the subsoil and very slow in the hardpan. Available water capacity is 3 to 6 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for irrigated small grain, alfalfa seed, alfalfa hay, occasional row crops, and wildlife habitat.

Representative profile of Chilcott silt loam, 2 to 5 percent slopes, about 100 feet east of the road on the north edge of the gravel pit in the NWl/4SW1/4SW1/4 section 21, T. 16 S., R. 47 E.:

A11-0 to 3 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; strong thin platy structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; many fine round pores; moderately alkaline; abrupt smooth boundary.

A12-3 to 13 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common fine roots; many fine tubular pores; moderately alkaline; abrupt smooth boundary.

IIB2t-13 to 18 inches; brown (10YR 5/3) silty clay, brown (10YR 5/3) crushed; very dark grayish brown (10YR 3/2) coatings on ped faces when moist; strong fine columnar and prismatic structure; very hard, very firm, very sticky and very plastic; few fine roots; few fine tubular pores; continuous thick clay films on ped faces and in pores; moderately alkaline; clear wavy boundary.

IIB3t-18 to 27 inches; yellowish brown (10YR 5/4) silty clay loam, brown (10YR 5/3) moist; very dark grayish brown (10YR 3/2) coatings on ped faces when moist; weak coarse angular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; common moderately thick day films on ped faces and in pores; moderately alkaline; clear wavy boundary.

IIC1-27 to 30 inches; light yellowish brown (10YR 6/4) silty clay loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, sticky and plastic; few fine roots; few fine tubular pores; moderately alkaline; abrupt wavy boundary.

IIC2ca-30 to 37 inches; light gray (10YR 7/2) silty clay loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, sticky and plastic; few fine roots; few fine tubular pores; strongly calcareous; strongly alkaline; abrupt smooth boundary.

IIC3casim-37 to 40 inches; strongly calcium- and silica-cemented duripan.

The A horizon has a value of 5.5 to 6.5 when dry and 3.5 to 4.5 when moist. It is silt loam or very fine sandy loam The Bt horizon is silty clay loam, silty clay, or clay. It is 35 to 50 percent clay and more than 30 percent silt. The depth to calcareous material ranges from about 15 to 30 inches. Depth to the duripan is 20 to 40 inches. Stratified sand and gravel occur under the duripan in most areas.

5B-Chilcott silt loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas on terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Malheur soils, about 10 percent Virtue soils, and about 5 percent Nyssa soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4.

5C-Chilcott silt loam, 5 to 12 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Malheur soils, about 10 percent Virtue soils, and about 5 percent Nyssa soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-3.

Duneland

6-Duneland. These miscellaneous areas consist of loose, wind drifted sands.

These areas are nearly devoid of vegetation, but some deep rooted shrubs grow. Capability unit VIIIe-1.

Falk Variant

The Falk Variant consists of moderately well drained soils that formed on high bottom lands or very low terraces in mixed alluvium. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,500 feet. The native vegetation was needlegrass, Indian ricegrass, Sandberg bluegrass, and big sagebrush. Average annual precipitation is 8 to 11 inches, average annual air temperature is 50 degrees to 52 degrees F, and the frost-free period is 120 to 170 days.

In a representative profile, the surface layer is grayish brown fine sandy loam about 7 inches thick. The upper part of the underlying material, to a depth of 11 inches, is grayish brown fine sandy loam; the next part, to a depth of 36 inches, is light brownish gray fine sandy loam; and the lower part is mottled very gravelly sand to a depth of 62 inches or more. The soil is moderately alkaline throughout.

Permeability is moderately rapid in the upper part and very rapid in the very gravelly sand. Available water capacity is 3 to 6 inches. Effective rooting depth is 60 inches or more. A seasonal water table is at a depth of 3 to 4 feet. Rare flooding occurs during spring runoff.

These soils are used for irrigated row crops, small grain, pasture, and wildlife habitat.

Representative profile of Falk Variant fine sandy loam about 200 feet west of high-tension power line, 100 feet south of the Snake River, SE1/4SW1/4 section 15, T. 18 S., R. 47 E.:

Ap--0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and coarse roots; many fine irregular pores; moderately alkaline; abrupt smooth boundary.

C1-7 to 11 inches; grayish brown (l0YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine and coarse roots; many fine irregular pores; weakly calcareous; moderately alkaline; gradual wavy boundary.

C2-11 to 22 inches; light brownish gray (10YR 6/2) fine sandy loam, grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; moderately calcareous; moderately alkaline; gradual wavy boundary.

C3-22 to 36 inches; light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist massive; soft, very friable slightly sticky and nonplastic; many fine roots; many fine irregular pores; moderately calcareous; moderately alkaline; gradual wavy boundary.

IIC4-26 to 62 inches; mottled very gravelly sand; single grained; loose; calcareous; moderately alkaline.

The A horizon has a value of 5 or 6 when dry and a chroma of 2 or 3 when dry and moist. In places it contains 10 to 20 percent gravel. Depth to very gravelly sand ranges from 20 to 40 inches.

7-Falk Variant fine sandy loam. This soil is in irregularly shaped Areas.

Included with this soil in mapping were about 10 percent Notus sandy loam, about 5 percent Cencove fine sandy loam, and about 2 percent Kimberly fine sandy loam.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate to high when the soil is disturbed and dry. Capability unit IVw-2.

Feltham series

The Feltham series consists of excessively drained soils that formed on terraces and fans in sandy alluvium that has been modified by wind. Slopes are 0 to 12 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was needlegrass, Indian ricegrass, rabbitbrush, and, big sagebrush. Average annual precipitation is 8 to 10 inches, average annual air temperature is 50 degrees to 52 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is brown loamy fine sand about 10 inches thick. The upper part of the underlying material, to a depth of 28 inches, is brown loamy fine sand; the middle part, to a depth of 42 inches, is brown fine sandy loam; and the lower part is pale brown loamy sand, to a depth of 60 inches or more. The soil is moderately alkaline throughout.

Permeability is rapid in the upper 28 inches and moderately rapid below a depth of 28 inches. Available water capacity is 3 to 6 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated corn, potatoes, onions, small grain, alfalfa hay, alfalfa seed, and wildlife habitat.

Representative profile of Feltham loamy fine sand, 0 to 2 percent slopes, in the NE1/4SW1/4NW1/4 section 24, T. 16 S., R. 47 E.:

Ap-0 to 10 inches; brown (10YR 5/3) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; many fine interstitial and tubular pores; moderately alkaline; abrupt smooth boundary.

C1-10 to 28 inches; brown (10YR 5/3) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; many fine interstitial and tubular pores; moderately alkaline; gradual wavy boundary.

C2- 28 to 42 inches; brown (10YR 5/3) fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many fine interstitial pores; moderately alkaline; gradual wavy boundary.

C3-42 to 60 inches; pale brown (10YR 6/3) loamy sand, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many fine interstitial pores; moderately alkaline.

The A horizon is brown, grayish brown, or light brownish gray loamy fine sand or sandy loam The soil is loamy fine sand or loamy sand between depths of 10 inches and 25 to 35 inches. The 10- to 40-inch control section averages loamy fine sand or loamy sand. Depth to stratified moderately coarse textured or medium textured material is 25 to 35 inches. Some pedons are calcareous below a depth of about 28 inches.

8A-Feltham loamy fine sand, 0 to 2 percent slopes. This soil is in irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Quincy soils, about 5 percent Feltham loamy fine sand that has slopes of 2 to 5 percent, about 5 percent Cencove soils, about 2 percent Feltham Variant loamy fine sand, and about 2 percent Feltham sandy loam.

Runoff is slow, .and the hazard of water erosion is slight. The hazard of soil blowing is moderate to severe. Capability unit IIIs-5.

8C-Feltham loamy fine sand, 8 to 12 percent slopes. This soil is in irregularly shaped areas. It has a profile similar to the one described as representative of the series, but the underlying material below a depth of 35 inches is laminated very fine sandy loam.

Included with this soil in mapping were about 10 percent Quincy soils, about 5 percent Feltham soils, and about 5 percent Feltham Variant loamy fine sand.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-5.

9B-Feltham sandy loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas. It has a profile similar to the one described as representative of the series, but the surface layer is sandy loam and the underlying material is loamy coarse sand and coarse sandy loam to a depth of 60 inches or more.

Included with this soil in mapping were about 10 percent Quincy soils, about 10 percent Cencove soils, about 5 percent Feltham loamy fine sand, and about 2 percent Feltham Variant loamy fine sand.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate to severe. Capability unit IIIe-3.

9C-Feltham sandy loam, 5 to 8 percent slopes. This soil is in irregularly shaped areas. It has a profile similar to the one described as representative of the series, but the surface layer is sandy loam and the underlying material is loamy coarse sand and coarse sandy loam to a depth of 60 inches or more.

Included with this soil in mapping were about 10 percent Quincy soils, about 10 percent Cencove soils, about 2 percent Feltham loamy fine sand, and about 2 percent Feltham Variant loamy fine sand.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate to severe. Capability unit IIIe-3.

9D-Feltham sandy loam, 8 to 12 percent slopes. This soil is in irregularly shaped areas. It has a profile similar to the one described as representative of the series, but the surface layer is sandy loam and the underlying material is loamy coarse sand and coarse sandy loam to a depth of 60 inches or more.

Included with this soil in mapping were about 15 percent Cencove soils and about 5 percent Feltham loamy fine sand.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-2.

Feltham Variant

The Feltham Variant consists of excessively drained soils that formed on terraces and fans in sandy alluvium that has been modified by wind. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was needlegrass, Indian ricegrass, rabbitbrush, and big sagebrush. Average annual precipitation is 8 to 10 inches, average annual air temperature is 50 degrees to 52 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is brown loamy fine sand about 5 inches thick. The upper part of the underlying material, to a depth of 26 inches, is brown and yellowish brown loamy sand; the middle part, to a depth of 31 inches, is yellowish brown fine sandy loam; and the lower part is multicolored very gravelly sand to a depth of 60 inches or more. The soil is mildly alkaline throughout.

Permeability is moderately rapid in the upper 31 inches and very rapid in the very gravelly sand. Available water capacity is 2 to 4 inches. Effective rooting depth is 30 to 40 inches.

These soils are used for irrigated corn, potatoes, onions, small grain, alfalfa hay, alfalfa seed, and wildlife habitat.

Representative profile of Feltham Variant loamy fine sand about 20 feet west of a farm road, 200 feet south of a barn in the NWl/4SE1/4NW1/4 section 19, T. 16 S., R. 48 E.:

Ap-0 to 5 inches; brown (10YR 5/3) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; loose, nonsticky and nonplastic; many roots; many fine tubular pores; mildly alkaline; abrupt smooth boundary.

C1-5 to 14 inches; brown (10YR 5/3) loamy sand, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; many roots; many fine tubular pores; mildly alkaline; gradual wavy boundary.

C2-14 to 26 inches; yellowish brown (10YR 5/4) loamy sand, dark brown (10YR 3/3) moist; massive; loose; nonsticky and nonplastic; many roots; many fine tubular pores; mildly alkaline; gradual wavy boundary.

C3-26 to 31 inches; yellowish brown (10YR 5/4) fine sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; many roots; irregular pores; slightly calcareous; mildly alkaline; abrupt wavy boundary.

IIC4-31 to 60 inches; multicolored very gravelly sand; single grained; loose; mildly alkaline.

The A horizon is grayish brown, light grayish brown or brown loamy fine sand. The soil is mildly or moderately alkaline throughout.

10-Feltham Variant loamy fine sand. This soil is in elongated areas. Slopes are 0 to 2 percent.

Included with this soil in mapping were about 5 percent Feltham loamy fine sand and about 5 percent Quincy soils. Also included were about 15 percent soils that are similar to Feltham Variant loamy fine sand but that have slopes of 2 to 8 percent.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate to severe. Capability unit IVs-3.

Frohman series

The Frohman series consists of well drained soils that formed on high terraces in loess-capped, medium textured old lacustrine material and very gravelly alluvium. Slopes are 0 to 20 percent. Elevation is 2,100 feet to 2,600 feet. The native vegetation was bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, and annual forbs. Average annual precipitation is 9 to 11 inches, average annual air temperature is 50 degrees to 54 degrees F, and the frost-free period is 130 to 170 days.

In a representative profile, the surface layer is light brownish gray silt loam about 8 inches thick. The subsoil is light brownish gray silt loam about 4 inches thick. The upper part of the substratum is a pale brown, silica-cemented hardpan 6 inches thick. Below this hardpan is light gray silt loam 18 inches thick Below this is a hardpan of very gravelly silica-cemented material. The soil is mildly alkaline above a depth of 8 inches and moderately alkaline below a depth of 8 inches.

Permeability is moderate above the hardpan and very slow in the hardpan. Available water capacity is 2 to 4 inches. Effective rooting depth is 10 to 20 inches.

These soils are used for irrigated small grain, alfalfa hay, pasture, and wildlife habitat.

Representative profile of the Frohman silt loam, 0 to 2 percent slopes, 30 feet north of the country road and 60 feet west of the center line in the SE1/4SW1/4 section 27, T. 18 S., R. 44 E.:

Ap-0 to 8 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak medium platy structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; mildly alkaline; abrupt smooth boundary.

B2-8 to 12 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine and very fine tubular pores; moderately alkaline; abrupt smooth boundary.

C1sim-12 to 18 inches; pale brown (10YR 6/3) indurated duripan of silt loam, dark brown (10YR 3/3) moist; massive; extremely hard, extremely firm; thin light gray (10YR 6/1) laminar cappings on the surface of the duripan; root mat on surface; many very fine tubular pores; moderately alkaline; clear wavy boundary.

C2-18 to 28 inches; light gray (10YR 7/2) silt loam, brown (l0YR 5/3) moist; massive; hard, friable, nonsticky and nonplastic; few very fine tubular pores; moderately alkaline; clear wavy boundary.

C3-28 to 36 inches; light gray (10YR 7/2) silt loam, pale brown (10YR 6/3) moist; massive; hard, friable, nonsticky and nonplastic; few very fine tubular pores; strongly calcareous; moderately alkaline; abrupt smooth boundary.

C4casim-36 to 42 inches; very gravelly indurated duripan; massive; extremely hard, extremely firm; pebbles coated with lime.

The A horizon is light brownish gray or pale brown when dry and very dark grayish brown, dark grayish brown, or dark brown when moist. The A and B horizons above the duripan are silt loam or very fine sandy loam They are less than 18 percent clay. Depth to the duripan ranges from 10 to 20 inches. Depth to very gravelly material ranges from 20 to 40 inches. Depth to bedrock is more than 60 inches. The underlying very gravelly dunpan is indurated or strongly cemented in the upper few inches and becomes less cemented with depth.

11A-Frohman silt loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas on terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 2 percent Nyssa soils and about 5 percent Virtue soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IVs-1.

11B-Frohman silt loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 2 percent Nyssa soils and about 5 percent Virtue soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IVe-1.

11C-Frohman silt loam, 5 to 8 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 2 percent Nyssa soils and about 5 percent Virtue soils.

Runoff is moderate, and the hazard of erosion is moderate. Capability unit IVe-1.

11D-Frohman silt loam, 8 to 12 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 5 percent Virtue soils and about 2 percent Nyssa soils.

Runoff is moderate, and the hazard of erosion is moderate. Capability unit IVe-3.

11E-Frohman silt loam, 12 to 20 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 2 percent Nyssa soils and about 2 percent Xeric Torriorthents, moderately steep.

Runoff is moderate, and the hazard of erosion is high. Capability unit VIe-1.

Garbutt series

The Garbutt series consists of well drained soils that formed on fans, bottom lands, and low terraces in mixed, medium textured alluvium. Slopes are 0 to 5 percent. Elevation is 2,100 to 2,400 feet. The native vegetation was needlegrass, Sandberg bluegrass, giant wildrye, big sagebrush, bursage, and fourwing saltbush. Average annual precipitation is 8 to 10 inches; average annual air temperature is 51 degrees to 53 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is very pale brown silt loam about 10 inches thick. The underlying material is pale brown and very pale brown silt loam to a depth of 62 inches. The soil is moderately alkaline throughout.

Permeability is moderate. Available water capacity is 10 to 12 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated onions, potatoes, sugar beets, corn, small grain, alfalfa hay, alfalfa seed, and wildlife habitat.

Representative profile of Garbutt silt loam, 0 to 2 percent slopes, about 60 feet west of Alkali Creek, 50 feet south of the county road in the NW1/4SW1/4 of section 11, T. 22 S., R. 46 E.:

Ap-0 to 10 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 4/3) moist; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many fine roots; many fine irregular and tubular pores; moderately alkaline; abrupt smooth boundary.

C1-10 to 23 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak very coarse prismatic structure; slightly hard, very friable, nonsticky and slightly plastic; many fine roots; many fine tubular pores; moderately calcareous; moderately alkaline; gradual wavy boundary.

C2ca-23 to 38 inches; very pale brown (`0YR 7/3) silt loam, brown (`0YR 4/3) moist; massive; slightly hard, very friable, nonsticky and slightly plastic; few fine roots; few fine tubular pores; moderately calcareous; moderately alkaline; gradual wavy boundary.

C3ca-38 to 62 inches; very pale brown (`0YR 7/3) silt loam, brown (`0YR 5/4) moist; massive; slightly hard, very friable, nonsticky and slightly plastic; few fine roots; few fine tubular pores; moderately calcareous; moderately alkaline.

The A horizon is dark grayish brown, very pale brown, or white when dry and dark grayish brown, grayish brown, or brown when moist. The 10- to 40-inch control section ranges from silt loam to very fine sandy loam, averages 12 to 18 percent clay and less than 15 percent particles coarser than very fine sand, and commonly contains much coarse silt. The soil is generally calcareous throughout. Some pedons have no free lime in the A horizon and very small amounts below, increasing with depth.

12A-Garbutt silt loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Umapine soils, about 10 percent Turbyfill soils, and about 3 percent Stanfield soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit I-1.

12B-Garbutt silt loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas.

Included with this soil in mapping were about 10 percent Owyhee soils and about 3 percent Turbyfill soils.

Runoff is slow, and the hazard of erosion is moderate. Capability unit IIe-2.

Greenleaf series

The Greenleaf series consists of well drained soils that formed on low and medium terraces in loess-capped, medium and fine textured old lacustrine material. Slopes are 0 to 5 percent. Elevation is 2,100 to 2,300 feet. The native vegetation was bluebunch wheatgrass, needlegrass, Sandberg bluegrass, big sagebrush, shadscale, and rabbit-brush. Average annual precipitation is 8 to 10 inches, average annual air temperature is 50 degrees to 52 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is light brownish gray silt loam about 8 inches thick. The subsoil is light brownish gray and brown silty clay loam about 23 inches thick. The substratum is very pale brown and light gray silt loam to a depth of 60 inches or more. The soil is mildly alkaline to a depth of 21 inches and moderately alkaline below a depth of 21 inches.

Permeability is moderately slow. Available water capacity is 10 to 13 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated onions, potatoes, sugar beets, corn, small grain, alfalfa hay, alfalfa seed, and wildlife habitat.

Representative profile of the Greenleaf silt loam, 0 to 2 percent slopes, in the SW1/4SW1/4 section 9, T. 16 S., R. 47 E.:

Ap-0 to 8 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (l0YR 4/2) moist; weak fine granular structure; hard, friable, slightly sticky and plastic; few fine roots; few fine tubular pores; mildly alkaline; abrupt smooth boundary.

B1-8 to 14 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; few fine roots; few fine tubular pores; mildly alkaline; abrupt wavy boundary.

B21t-14 to 21 inches; brown (10YR 5/3) light silty clay loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and very plastic; few fine roots; few fine tubular pores; continuous thin clay films on peds; mildly alkaline; gradual wavy boundary.

B22t-21 to 31 inches; brown (10YR 5/3) light silty clay loam, brown to dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and very plastic; few fine roots; few fine tubular pores; continuous thin clay films on peds; moderately alkaline; abrupt wavy boundary.

C1ca-31 to 36 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; hard, friable, slightly sticky and plastic; few fine roots; few fine tubular pores; strongly calcareous; moderately alkaline; abrupt smooth boundary.

C2ca-36 to 60 inches; light gray (10YR 7/2) silt loam, brown to dark brown (10YR 6/3) moist; fine and medium platy laminations of old alluvium; hard, friable, sticky and plastic; no roots; few fine irregular pores; moderately alkaline.

The A horizon has a value of 5 to 7 when dry and 3 or 4 when moist and a chroma of 2 or 3 when dry and moist. It is not darker in value than 5.5 when dry and 3.5 when moist, both when broken and when rubbed. The Bt horizon averages 22 to 28 percent clay and is less than 15 percent particles coarser than very fine sand. It has common thin to nearly continuous moderately thick clay films on the faces of peds and walls of pores. Depth to laminated material is 20 to 40 inches.

13A-Greenleaf silt loam, 0 to 2 percent slopes. This soil is in large, rounded areas on broad terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 5 percent Owyhee soils and about 5 percent Nyssa soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit I-1.

13B-Greenleaf silt loam, 2 to 5 percent slopes. This soil is in large, rounded areas on broad terraces.

Included with this soil in mapping were about 5 percent Owyhee soils, about 5 percent Nyssa soils, and about 5 percent Greenleaf soils that have slopes of 5 to 12 percent.

Runoff is slow, and the hazard of erosion is moderate. Capability unit IIe-2.

Harana series

The Harana series consists of moderately well drained soils that formed on bottom lands in moderately fine textured, mixed alluvium. Slopes are 0 to 2 percent. Elevation is 2,200 to 2,600 feet. The native vegetation was giant wildrye, sod-forming bluegrass, big sagebrush, and related forbs. Average annual precipitation is 9 to 11 inches, average annual air temperature is 48 degrees to 52 degrees F, and the frost-free period is 130 to 160 days.

In a representative profile, the surface layer is dark gray and gray silty clay loam about 24 inches thick. The upper part of the underlying material, to a depth of 43 inches, is dark gray silty clay loam, and the lower part is black clay to a depth of 60 inches or more. The soil is mildly alkaline to a depth of about 16 inches and moderately alkaline below that depth.

Permeability is moderately slow. Available water capacity is 10 to 12 inches. Effective rooting depth is 60 inches or more. Rare flooding occurs during spring runoff.

These soils are used for irrigated alfalfa hay, small grain, sugar beets, corn, and wildlife habitat.

Representative profile of Harana silty clay loam 60 feet west of Willow Creek, 600 feet north of the section line (fence line), SW1/4SE1/4SW1/4 section 32, T. 15 S., R. 43 E.:

Ap-0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; strong fine granular structure; hard, firm, sticky and plastic; many very fine to medium roots; many fine irregular pores; mildly alkaline; abrupt smooth boundary.

A11-8 to 16 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium blocky structure parting to strong very fine subangular blocky; hard, firm, sticky and plastic; many very fine to medium roots; many very fine tubular pores; mildly alkaline; gradual wavy boundary.

A12-16 to 24 inches; gray (10YR 5/1) silty clay loam, black (10YR 2/1) moist; strong very fine subangular blocky structure; very hard, firm, sticky and plastic; many very fine to medium roots; many very fine tubular pores; moderately alkaline; gradual wavy boundary.

C1ca-24 to 34 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak very fine subangular blocky structure; very hard, firm, sticky and plastic; many very fine to medium roots; many very fine tubular pores; calcareous, with segregated lime; moderately alkaline; gradual smooth boundary.

C2-34 to 43 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak very fine subangular blocky structure; very hard, firm, sticky and plastic; many very fine to medium roots; many very fine tubular pores; moderately alkaline; gradual wavy boundary.

C3-43 to 60 inches; black (N 2/) clay, black (N 2/) moist; massive; very hard, very firm, very sticky and very plastic; few medium roots; few fine irregular pores; moderately alkaline.

The soil is silty clay loam throughout the control section and averages 27 to 35 percent clay and less than 15 percent material coarser than very fine sand. The C horizon below a depth of 40 inches has a value of 2 or 3 when moist and a chroma of 1 or less; high chroma mottles are in some pedons. The C horizon below a depth of 40 inches is silty clay loam, silty clay; or clay.

14-Harana silt loam. This soil is in regularly shaped areas on bottom lands along perennial streams. It has a profile similar to the one described as representative of the series, but the surface layer is silt loam 11 to 24 inches thick.

Included with this soil in mapping were about 10 percent Harana silty clay loam; about 5 percent Harana silty clay loam, alkali; about 5 percent Powder soils; and about 5 percent Umapine soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIc-1.

15-Harana silty clay loam. This soil is in regularly shaped areas on bottom lands along perennial streams. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Harana silt loam; about 5 percent Harana silty clay loam, alkali; about 5 percent Powder soils; and about 5 percent Umapine soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIc-1.

16-Harana silty clay loam, alkali. This soil is in regularly shaped areas on bottom lands along perennial streams. It has a profile similar to the one described as representative of the series, but the surface layer is gray, about 9 inches thick, strongly alkaline, and high in exchangeable sodium.

Included with this soil in mapping were about 10 percent Harana silty clay loam, about 10 percent Umapine soils, and about 5 percent Harana silt loam.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIs-3.

Kiesel series

The Kiesel series consists of well drained alkali soils that formed on low terraces in mixed alluvium. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,200 feet. The native vegetation was saltgrass, greasewood, and rabbitbrush. Average annual precipitation is 9 to 11 inches, average annual air temperature is 51 degrees to 53 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is light gray silt loam about 4 inches thick. The subsoil is light brownish gray and light gray silty clay about 18 inches thick. The upper part of the substratum is light gray silt loam to a depth of 40 inches, and the lower part is light gray loam and very fine sandy loam to a depth of 60 inches or more. The soil is strongly alkaline in the upper 4 inches and very strongly alkaline below a depth of 4 inches.

Permeability is slow. Available water capacity is 7 to 9 inches. Effective rooting depth is 60 inches or more. A seasonal water table is at a depth of 3 to 4 feet in spring.

These soils are used mostly for irrigated and subirrigated pasture and for some alfalfa hay.

Representative profile of Kiesel silt loam 400 feet south and 100 feet west of the section corner in the NEl/4NE1/4 of section 8, T. 19 S., R. 47 E.:

A1-0 to 4 inches; light gray (10YR 7/2) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; many very tine round pores; weakly calcareous; strongly alkaline; abrupt smooth boundary.

B21t-1 to 7 inches; light brownish gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; thin light gray (10YR 7/2) and grayish brown (10YR 5/2) silt coatings; weak fine prismatic structure parting to moderate fine and medium subangular blocky; hard, firm, very sticky and very plastic; common very fine roots; many very fine tubular pores; common thin and few moderately thick clay films; strongly calcareous; very strongly alkaline; clear smooth boundary.

B22t-7 to 11 inches; light gray (10YR 7/2) silty clay, brown (10YR 4/3) moist; strong fine subangular blocky structure; hard, firm, sticky and very plastic; many very fine roots; common very fine tubular pores; clay films as above; strongly calcareous; very strongly alkaline; clear smooth boundary.

B23t-11 to 22 inches; light gray (10YR 7/2) silty clay, brown (10YR 4/3) moist; strong fine subangular blocky structure; hard, firm, sticky and very plastic; common very fine roots; many very fine tubular pores; clay films as above; strongly calcareous; very. strongly alkaline; clear smooth boundary.

C1ca-22 to 40 inches; light gray (10YR 7/1) heavy silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky and plastic; few fine roots; few very fine tubular pores; violently calcareous; very strongly alkaline; clear wavy boundary.

C2ca-10 to 60 inches; light gray (10YR 7/1) loam and very fine sandy loam, brown (10YR 5/3) moist; slightly hard, friable slightly sticky and slightly plastic; strongly calcareous; very strongly alkaline

The A horizon has a value of 6 or 7 when dry and a chroma of 2 or 3 when moist. The B2t horizon is silty clay or clay and contains an average of 40 to 50 percent clay. It contains more than 15 percent exchangeable sodium and has weak prismatic or columnar structure parting to moderate or strong subangular blocky structure. The Cca horizon has a value of 6 or 7 when dry, and a chroma of 1 or 2 when dry and 2 or 3 when moist. It is silt loam or silty clay loam in the Clca horizon and silt loam, loam, or very fine sandy loam in the C2ca horizon

17-Kiesel silt loam. This soil is in irregularly shaped areas on low terraces adjacent to the Snake River.

Included with this soil in mapping were about 10 percent Baldock soils, about 5 percent Umapine soils, and about 5 percent Stanfield soils.

Runoff is slow, and the hazard of erosion is slight. .Capability unit IVs-2.

Kimberly series

The Kimberly series consists of well drained soils that formed on bottom lands and fans in moderately coarse textured alluvium. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,500 feet. The native vegetation was needlegrass, giant wildrye, big sagebrush, and rabbitbrush. Average annual precipitation is 8 to 11 inches, average annual air temperature is 48 degrees to 52 degrees F, and the frost-free period is 130 to 170 days.

In a representative profile the surface layer is grayish brown fine sandy loam about 8 inches thick. The underlying material is grayish brown fine sandy loam and sandy loam to a depth of 48 inches. The soil is moderately alkaline throughout.

Permeability is moderately rapid. Available water, capacity is 6 to 9 inches. Effective rooting depth is 40 to 60 inches or more. Rare flooding occurs during spring runoff.

These soils are used for irrigated onions, potatoes, sugar beets, small grain, alfalfa hay, and wildlife habitat.

Representative profile of Kimberly fine sandy loam 50 feet south of the first power pole from river irrigation pump and 120 feet east of the concrete lined ditch, SEl/4SW1/4NE1/4 section 21, T. 18 S., R. 45 E.:

Ap-0 to 8 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine and coarse roots; many fine irregular and tubular pores; moderately alkaline; abrupt smooth boundary.

C1-8 to 35 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; many fine and coarse roots; many fine irregular and tubular pores; moderately alkaline; gradual wavy boundary.

C2-35 to 48 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; common coarse roots; few irregular and tubular pores; moderately alkaline.

In some places gravel occurs below a depth of 40 inches, but generally it is below a depth of 60 inches.

18-Kimberly fine sandy loam. This soil is in irregularly shaped areas on alluvial bottom lands (fig. 1). Slopes are 0 to 2 percent.

Included with this soil in mapping were about 10 percent Powder soils, about 5 percent Poden soils, and about 3 percent Umapine soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit I-1.

Malheur series

The Malheur series consists of well drained soils that formed on old terraces in medium textured material over a cemented hardpan. Slopes are 0 to 8 percent. Elevation is 2,400 to 2,600 feet. The native vegetation was Thurber needlegrass, Sandberg bluegrass, sixweeks fescue, bluebunch wheatgrass, and big sagebrush. Average annual precipitation is 9 to 11 inches, average annual air temperature is 50 degrees to 54 degrees F, and the frost-free period is 140 to 170 days.

In a representative profile, the surface layer is pale brown silt loam about 9 inches thick The subsoil is brown silty clay loam about 10 inches thick The upper part of the substratum, to a depth of 23 inches, is very pale brown silt loam, and the middle part is an indurated hardpan 3 inches thick Below the hardpan, the substratum is very pale brown silt loam to a depth of 42 inches. The soil is moderately alkaline to a depth of 15 inches and strongly alkaline below a depth of 15 inches.

Permeability is moderately slow in the subsoil. The hardpan is impervious or has very slow permeability. Available water capacity is 4 to 8 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for irrigated small grain, alfalfa hay, pasture, and wildlife habitat.

Representative profile of Malheur silt loam in an area of Nyssa-Malheur silt loams, 0 to 2 percent slopes, in the NE1/4NE1/4SE1/4 section 34, T. 19 S.,1;.. 46 E.:

Ap-0 to 9 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many fine roots; many fine round vesicular pores in the upper 1 inch; moderately alkaline; abrupt smooth boundary.

B21t-9 to 15 inches; brown (10YR 5/3) silty clay loam, dark brown to brown (10YR 4/3) moist; strong fine columnar structure parting to strong fine angular blocky; very hard, firm, sticky and plastic; many fine roots; very few fine tubular pores; continuous thin clay films on ped faces and in pores; moderately alkaline; gradual wavy boundary.

B22t-15 to 19 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; strong fine angular blocky structure; very hard, firm, sticky and plastic; few fine roots; very few tine tubular pores; discontinuous thin clay films on ped fads and in pores; strongly alkaline; gradual wavy boundary.

IIC1ca-19 to 23 inches; very pale brown (10YR 7/3) silt loam, grayish brown (10YR 5/3) moist; weak fine angular blocky structure, slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; strongly alkaline; abrupt wavy boundary.

IIC2casim-23 to 26 inches; white (10YR 8/2) indurated duripan ; very pale brown (10YR 7/4) moist; platy; continuous silica laminar capping, very strongly calcareous; abrupt wavy boundary.

IIC3-26 to 42 inches; very pale brown (10YR 7/3) silt loam, grayish brown (10YR 5/3) moist; massive; soft, very friable, nonsticky and nonplastic; few fine irregular pores; strongly alkaline.

The A horizon has a value of 6 or 7 when dry and 3 or 4 when moist and a chroma of 2 or 3 when dry and moist. It is silt loam or very fine sandy loam. The B2t horizon has a value of 5 or 6 when dry and 3 or 4 when moist and a chroma of 2 or 3 when dry and moist. It is silty clay loam that is 27 to 35 percent clay and less than 15 percent material coarser than very fine sand. Depth to the duripan ranges from 20 to 40 inches but is generally 22 to 30 inches. Stratified, medium textured lake-laid sediments occur under the duripan in most areas.

This soil is mapped only in complex with Nyssa soils.

McLoughlin series

The McLoughlin series consists of well drained soils that formed on fans in mixed alluvium. Slopes are 0 to 8 percent: Elevation is 2,100 to 2,600 feet. The native vegetation was shadscale, greasewood, saltgrass, and alkaline-tolerant forbs. Average annual precipitation is 8 to 10 inches, average annual air temperature is 48 degrees to 52 degrees F, and the frost-free period is 120 to 170 days.

In a representative profile, the surface layer is very pale brown silt loam about 9 inches thick. The subsoil is very pale brown silt loam about 11 inches thick. The upper part of the substratum, to a depth of 50 inches, is very pale brown light silty clay loam, and the lower part is stratified silty clay loam and silt loam to a depth of 60 inches. The soil is moderately alkaline to a depth of 9 inches and strongly alkaline below a depth of 9 inches.

Permeability is moderately slow. Available water capacity is 8 to 12 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated small grain, alfalfa hay, pasture, an occasional crop of sugar beets, and wildlife habitat.

Representative profile of McLoughlin silt loam, 0 to 2 percent slopes, about 700 feet north of Succor Creek, channel, NE1/4SE1/4SE1/4 section 2, T. 23 S., R. 46 E.:

Ap1-0 to 3 inches; very pale brown (10YR 7/3) silt loam, dark brown (10YR 4/3) moist; strong thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; many very fine irregular pores; very weakly calcareous in spots; moderately alkaline; abrupt smooth boundary.

Ap2-3 to 9 inches; very pale brown (10YR 7/3) silt loam, dark brown (10YR 4/3) moist; moderate fine and medium granular structure; soft, very friable, sticky and plastic; many roots; many very fine irregular pores; very weakly calcareous in spots; moderately alkaline; abrupt smooth boundary.

B2-9 to 20 inches; very pale brown (10YR 7/3) silt loam, dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure; hard, friable, sticky and plastic; common large roots; common very fine tubular pores; weakly calcareous; strongly alkaline; gradual wavy boundary.

C1ca-20 to 28 inches; very pale brown (10YR 7/3) light silty clay loan, yellowish brown (10YR 5/4) moist; massive; hard, friable, sticky and plastic; common large roots; common very fine tubular pores; moderately calcareous; strongly alkaline; gradual wavy boundary.

C2ca-28 to 50 inches; very pale brown (10YR 7/3) light silty clay loam, yellowish brown (10YR 4/4) moist; massive; hard, friable, sticky and plastic; strongly calcareous; strongly alkaline; gradual wavy boundary.

C3-50 to 60 inches; stratified silty clay loam and silt loam, similar to above in color and consistency; massive.

The profile to a depth of 40 inches or more has a value of 6 or 7 when dry, 4 or 5 when moist, and a chroma of 3 or 4 when dry and moist. The solum is silt loam, loam, or silty clay loam. It is 18 to 35 percent clay and less than 15 percent fine sand and coarser. Depth to bedrock is more than 60 inches. The solum is stratified with medium and moderately fine textured alluvium washed from adjacent uplands of silty lacustrine sediments.

19A-McLoughlin silt loam, 0 to 2 percent slopes. This soil is in regularly shaped areas on alluvial fans. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Garbutt soils, about 5 percent Stanfield soils, and about 5 percent Umapine soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIs-3.

19B-McLoughlin silt loam, 2 to 5 percent slopes. This soil is in regularly shaped areas on alluvial fans.

Included with this soil in mapping were about 10 percent Garbutt soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIs-4.

19C-McLoughlin silt loam, 5 to 8 percent slopes. This soil is in regularly shaped areas on alluvial fans.

Included with this soil in mapping were about 5 percent McLoughlin silt loam that has slopes of 8 to 12 percent.

Runoff is medium, and the hazard of erosion is moderate to high. Capability unit IIIs-4.

Notus series

The Notus series consists of moderately well drained or somewhat poorly drained soils that formed on bottom lands and very low terraces in gravelly sandy alluvium. Slopes are 0 to 2 percent. Elevation is 2,200 to 2,500 feet. The native vegetation was needlegrass, squirreltail, rabbitbrush, and big sagebrush. Average annual precipitation is 9 to 11 inches. Average annual air temperature is 50 degrees to 52 degrees F, and the frost-free period is 120 to 170 days.

In a representative profile, the surface layer is light brownish gray coarse sandy loam about 8 inches thick The substratum is light brownish gray very gravelly loamy coarse sand to a depth of 60 inches. The soil is moderately alkaline throughout.

Permeability is moderately rapid above a depth of 11 inches and very rapid below a depth of 11 inches. Available water capacity is 2 to 4 inches. Effective rooting depth is 60 inches or more. A seasonal water table is at a depth of 2 to 4 feet in summer. Occasional flooding occurs during spring runoff.

These soils are used for irrigated pasture and wildlife habitat.

Representative profile of Notus coarse sandy loam in an area of Notus-Falk Variant complex, about 200 feet north of the Malheur River, about 200 feet west of the fence along the county road in the NW1/4NW1/4 section 16, T. 48 S., R. 46 E.:

Ap-0 to 8 inches; light brownish gray (10YR 6/2) coarse sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; loose, very friable, slightly sticky and nonplastic; many fine and coarse roots; many irregular pores; moderately alkaline; abrupt smooth boundary.

C1-8 to 11 inch; light brownish gray (10YR 6/2) coarse sandy loam, dark brown (10YR 4/3) moist; common fine faint dark yellowish brown (10YR 4/4) mantle; massive; soft, very friable, slightly sticky and nonplastic; many fine coarse roots; many irregular pores; moderately alkaline; abrupt wavy boundary.

IIC2-11 to 60 inches; light brownish gray (10YR 6/2) very gravelly loamy coarse sand, dark brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; few coarse roots; many irregular pores; moderately alkaline.

The A horizon has a value of 5 or 6 when dry and a chroma of 2 or 3 when moist and dry. The A horizon is coarse sandy loam or sandy loam and contains 10 to 30 percent coarse fragments. The IIC horizon has a value of 5 or 6 when dry and a chroma of 2 or 3 when dry and moist. Texture is loamy coarse sand, loamy sand, or sand and contains 35 to 80 percent coarse fragments. Depth to the IIC horizon ranges from 10 to 20 inches.

20-Notus-Falk Variant complex. This complex consists of about 50 to 60 percent Notus coarse sandy loam, about 20 to 30 percent Falk Variant fine sandy loam, about 15 percent Kimberly fine sandy loam, and about 5 percent Poden silt loam. It is in irregularly shaped areas.

Runoff is slow, and the hazard of erosion by overflow from adjacent rivers is severe. Capability unit IVw-2.

Nyssa series

The Nyssa series consists of well drained soils that formed on terraces in medium textured material over old lake-laid sediments. Slopes range from 0 to 20 percent but generally are less than 8 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was needlegrass, Sandberg bluegrass, annual fescue, big sagebrush, shadscale, bud sagebrush, and forbs. Average annual precipitation is 9 to 11 inches, the average annual air temperature is 50 degrees to 54 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is light brownish gray silt loam about 13 inches thick. The subsoil is pale brown silt loam about 7 inches thick. The substratum is light gray silt loam to a depth of 25 inches. Below this is a silica-cemented hardpan about 6 inches thick. Below the hardpan, the substratum is very pale brown laminated silt loam, fine sandy loam, and loam to a depth of 60 inches. The soil is mildly alkaline above a depth of 13 inches, neutral between depths of 13 and 20 inches, moderately alkaline between depths of 20 and 31 inches, and very strongly alkaline below a depth of 31 inches.

Permeability is moderate above the hardpan and slow to very slow in the hardpan and the underlying laminated sediments. Available water capacity is 4 to 8 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for irrigated onions, potatoes, sugar beets, small grain, vegetable seeds, alfalfa seed, alfalfa hay, and wildlife habitat.

Representative profile of Nyssa silt loam, 0 to 2 percent slopes, about 80 feet southeast of vertical standpipe turnout, NW1/4SW1/4SW1/4 section 11, T. 20 S., R. 46 E.:

Ap-0 to 13 inches; light brownish gray (10YR 6/2) silt loan, dark grayish brown (10YR 4/2) moist; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; mildly alkaline; clear smooth boundary.

B2-13 to 20 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; neutral; clear wavy boundary.

C1casi-20 to 25 inches; light gray (10YR 7/2) silt loam, grayish brown and brown (10YR 5/2 and 5/3) moist; massive; hard, firm, slightly sticky and slightly plastic; few roots; common very fine tubular pores; 45 percent calcareous durinodes 1/4 to 1 inch by 1/4 to 1/2 inch; strongly calcareous; moderately alkaline; abrupt wavy boundary.

C2casim-25 to 31 inches; light gray (10YR 7/2) indurated duripan of silty material, brown (10YR 5/3) moist; weak very thick platy structure; thin silica-indurated lenses on top of plates with a matting of roots and reddish brown organic matter on top of silica lenses; extremely hard, extremely firm, nonsticky and nonplastic; no roots except for mats on lenses; many very fine and fine tubular pores; strongly calcareous; moderately alkaline; clear wavy boundary.

C3-31 to 60 inches; very pale brown (10YR 7/3) silt loam, fine sandy loam, and loam; laminated; hard; strongly calcareous; very strongly alkaline.

The A horizon has a value of 3 or 4 when moist and a chroma of 2 or 3 when moist or dry. The A and B horizons above the duripan are silt loam or very fine sandy loam. They are less than 18 percent clay and less than 15 percent fine and coarser sand The A and B horizons above the dunpan are neutral to moderately alkaline and commonly noncalcareous, but in some pedons the B horizon is weakly calcareous. Depth to the duripan ranges from 20 to 40 inches but is dominantly 20 to 30 inches. Some pedons have very gravelly coarse sand below the dunpan. Depth to bedrock is more than 60 inches.

21A-Nyssa silt loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas on terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 20 percent soils that are similar to Nyssa soils but that are 15 to 20 inches deep to the hardpan. Also included are about 10 percent Owyhee soils; about 5 percent Nyssa soils, gravel substratum; about 5 percent Truesdale soils; and about 1 percent Virtue soils.

Runoff is slow, and the erosion hazard is slight. Capability unit IIIs-1.

21B-Nyssa silt loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent soils that are similar to Nyssa soils but that are 15 to 20 inches deep to the hardpan. Also included are about 10 percent Owyhee soils; about 5 percent Nyssa soils, gravel substratum; about 5 percent Truesdale soils; and about 1 percent Virtue soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIe-1.

21C-Nyssa silt loam, 5 to 8 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 15 percent soils that are similar to Nyssa soils but that are 15 to 20 inches deep to the hardpan. Also included are about 10 percent Owyhee soils; about 5 percent Nyssa soils, gravel substratum; and about 5 percent Truesdale soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1.

21D-Nyssa silt loam, 8 to 12 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 20 percent soils that are similar to Nyssa soils but that are 15 to 20 inches deep to the hardpan. Also included are about 10 percent Owyhee soils; about 5 percent Nyssa soils, gravel substratum; and about 5 percent Truesdale soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-4.

21E-Nyssa silt loam, 12 to 20 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 25 percent soils that are similar to Nyssa soils but that are 15 to 20 inches deep to the hardpan. Also included are about 10 percent Owyhee soils; about 5 percent Nyssa soils, gravel substratum; and about 5 percent Truesdale soils.

Runoff is moderate, and the hazard of erosion is moderate to severe. Capability unit VIe-2.

22A-Nyssa silt loam, gravel substratum, 0 to 2 percent slopes. This soil is in irregularly shaped areas on medium terraces. It has a profile similar to the one described as representative of the series, but very gravelly sand is below the hardpan.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Truesdale soils, about 5 percent Cencove soils, and about 5 percent Sagehill soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIs-2.

22B-Nyssa silt loam, gravel substratum, 2 to 5 percent slopes. This soil is in irregularly shaped areas on medium terraces. It has a profile similar to the one described as representative of the series, but very gravelly sand is below the hardpan.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Truesdale soils, about 5 percent Cencove soils, and about 5 percent Sagehill soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIe-2.

22C-Nyssa silt loam, gravel substratum, 5 to 8 percent slopes. This soil is in irregularly shaped areas on medium terraces. It has a profile similar to the one described as representative of the series, but very gravelly sand is below the hardpan.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Truesdale soils, and about 5 percent Cencove soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-2.

22D-Nyssa silt loam, gravel substratum, 8 to 12 percent slopes. This soil is in irregularly shaped areas on medium terraces. It has a profile similar to the one described as representative of the series, but very gravelly sand is below the hardpan.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Truesdale soils, and about 5 percent Cencove soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-3.

22E-Nyssa silt loam, gravel substratum, 12 to 20 percent slopes. This soil is in irregularly shaped areas on medium terraces. It has a profile similar to the one described as representative of the series, but very gravelly sand is below the hardpan.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Truesdale soils, and about 5 percent Cencove soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit VIe-1.

23A-Nyssa-Malheur silt loams, 0 to 2 percent slopes. This complex consists of about 50 to 60 percent Nyssa silt loam; about 20 to 40 percent Malheur silt loam; about 5 percent Virtue soils; about 5 percent Nyssa silt loam, gravel substratum; and about 5 percent Owyhee soils. It is in irregularly shaped areas on terraces. Runoff is slow, and the hazard of erosion is slight. Capability unit IIIs-1.

23B-Nyssa-Malheur silt loams, 2 to 5 percent slopes. This complex consists of about 50 to 60 percent Nyssa silt loam; about 20 to 40 percent Malheur silt loam; about 5 percent Virtue soils; about 5 percent Nyssa silt loam, gravel substratum; and about 5 percent Owyhee soils. It is in irregularly shaped areas on terraces.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1.

23C-Nyssa-Malheur silt loams, 5 to 8 percent slopes. This complex consists of about 50 to 60 percent Nyssa silt loam; about 20 to 40 percent Malheur silt loam; about 5 percent Virtue soils; about 5 percent Nyssa silt loam, gravel substratum; and about 5 percent Owyhee soils. It is in irregularly shaped areas on terraces.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1.

Otoole series

The Otoole series consists of somewhat poorly drained soils that formed on low terraces in medium textured alluvium. Slopes are 0 to 2 percent. Elevation is 2,200 to 2,600 feet. The native vegetation was saltgrass, giant wildrye, and greasewood. Average annual precipitation is 8 to 10 inches, average annual air temperature is 48 degrees to 52 degrees F, and the frost-free period is 110 to 150 days.

In a representative profile, the surface layer is pale brown silt loam about 10 inches thick. The upper part of the underlying material, to a depth of 17 inches, is very pale brown silt loam, and the lower part is a silica-cemented hardpan. The soil is very strongly alkaline throughout.

Permeability is moderate above the hardpan and very slow in the hardpan. Available water capacity is 1.5 to 3.5 inches. Effective rooting depth is 10 to 20 inches. A seasonal water table is at a depth of 2 to 4 feet during the irrigation period.

These soils are used for irrigated pasture and wildlife habitat.

Representative profile of Otoole silt loam about 550 feet east and 50 feet south of Hope school house in the SW1/4SW1/4 section 5, T. 19 S., R. 44 E.:

A1-0 to 6 inches; pale brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) moist; strong fine platy structure; soft, very friable, nonsticky and slightly plastic; many fine roots; many very fine pores; strongly calcareous; very strongly alkaline; abrupt smooth boundary.

AC-6 to 10 inches; pale brown (10YR 6/3) silt loam, very dark grayish brown (10YR 3/2) moist; massive parting to weak coarse prismatic structure; soft, very friable, nonsticky and slightly plastic; few very fine roots; few very fine and fine tubular pores; strongly calcareous; very strongly alkaline; gradual smooth boundary.

C1-10 to 17 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 4/3) moist; massive; soft matrix containing 50 percent hard durinodes; very friable, nonsticky and slightly plastic; few very fine roots; few very fine and fine tubular pores; strongly calcareous; very strongly alkaline; abrupt smooth boundary.

C2casim-17 to 30 inches; brown (10YR 4/3) silica-cemented duripan; weak thick platy structure; very firrr4 strongly cemented with thin indurated lenses on top of plates; indurated laminar capping nearly continuous; strongly calcareous; very strongly alkaline.

The A and AC horizons have a value of 5.5 to 6 when dry and 3 to 4 when moist. They are silt loam or very fine sandy loam The C horizon has a value of 6 or 7 when dry and 3 or 4 when moist and a chroma of 3 when dry or moist. It is silt loam. Content of durinodes ranges from 0 to 60 percent. Depth to the duripan is 10 to 20 inches. Depth to bedrock is more than 60 inches and typically is many feet.

24-Otoole silt loam. This soil is in rounded areas on low terraces.

Included with this soil in mapping were about 10 percent Stanfield soils, about 5 percent Umapine soils, and about 2 percent Powder soils.

Flooding occurs rarely on this soil. Runoff is slow, and the hazard of erosion is slight. Capability unit IVw-1.

Owyhee series

The Owyhee series consists of well drained soils that formed on terraces in loess-capped old lacustrine materials. Slopes range from 0 to 20 percent but are generally less than 8 percent. Elevation is 2,100 to 2,500 feet. The native vegetation was bluebunch wheatgrass, needlegrass, Sandberg bluegrass, big sagebrush, shadscale, and rabbitbrush. Average annual precipitation is 8 to 10 inches, average annual air temperature is 50 degrees to 52 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is pale brown silt loam about 10 inches thick. The subsoil is pale brown silt loam about 6 inches thick. The upper part of the substratum, to a depth of 28 inches, is white silt loam, and the lower part is light gray laminated silt loam and very fine sandy loam to a depth of 60 inches. The soil is moderately alkaline above a depth of 28 inches; strongly alkaline between depths of 28 and 38 inches, and moderately alkaline below a depth of 38 inches.

Permeability is moderate in the upper part and moderately slow in the laminated sediments. Available water capacity is 9 to 12 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated onions, potatoes, sugar beets, small grain, vegetable seeds, alfalfa seed, alfalfa hay (fig. 2), and wildlife habitat.

Representative profile of Owyhee silt loam, 0 to 2 percent slopes, about 200 feet north and 30 feet east of the section corner, SW1/4SW1/4SW1/4 section 33, T. 20 S., R. 46 E.:

Ap-0 to 10 inches; pale brown (10YR 6/3) silt loam, dark brown to brown (10YR 4/3) moist; weak fine granular structure; soft, very friable slightly sticky and slightly plastic; many fine roots; many fine tubular pores; moderately alkaline; abrupt smooth boundary.

B-10 to 16 inches; pale brown (10YR 6/3) silt loam, dark brown to brown (10YR 4/3) moist; moderate coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; moderately alkaline; abrupt wavy boundary.

C1ca-16 to 28 inches; white (10YR 8/2) silt loam, brown (10YR 5/3) moist; massive; hard, firm, nonsticky and nonplastic; few coarse roots; few fine tubular pores; strongly calcareous; moderately alkaline; abrupt wavy boundary.

C2-28 to 38 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; laminated lacustrine sediments in moderate medium plates that part to weak fine and medium angular and subangular blocks; hard, firm, nonsticky and nonplastic; few coarse roots; few medium tubular pores; moderately calcareous; strongly alkaline; abrupt smooth boundary.

C3-38 to 50 inches; light gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) moist; laminated lacustrine sediments in weak medium plates that part to weak fine and medium angular and subangular blocks; hard, friable, nonsticky and nonplastic; few coarse roots; few medium tubular pores and many fine irregular pores; moderately calcareous; moderately alkaline; abrupt smooth boundary.

C4-50 to 60 inches; light gray (10YR 7/2) silt loam, yellowish brown (10YR 5/4) moist; laminated lacustrine sediments in weak medium plates that part to weak fine and medium angular and subangular blocks; hard, friable, slightly sticky and slightly plastic; few fine irregular pores; weakly calcareous; moderately alkaline.

The A horizon has a value of 5.5 to 6.5 when dry and 3.5 to 4.5 when moist and a chroma of 2 to 3. It is noncalcareous and neutral to moderately alkaline. It is silt loam or loam. The B horizon is noncalcareous to a depth of 12 to 24 inches. The upper boundary of the Cca horizon is below a depth of 16 inches. In places the Cca horizon contains few or common, hard, firm, rounded nodules of soil material or cicada krotovinas 0.5 to 0.8 inch in diameter. Depth to the underlying laminated sediments ranges from about 20 to 35 inches.

25A-Owyhee silt loam, 0 to 2 percent slopes. This soil is in regularly shaped areas on terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Nyssa soils, about 5 percent Greenleaf soils, and about 5 percent Nyssa silt loam, gravel substratum.

Runoff is slow, and the hazard of erosion is slight. Capability unit I-1.

25B-Owyhee silt loam, 2 to 5 percent slopes. This soil is in regularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Nyssa soils and about 5 percent Nyssa silt loam, gravel substratum.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-2.

25C-Owyhee silt loam, 5 to 8 percent slopes. This soil is in regularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Nyssa soils and about 5 percent Nyssa silt loam, gravel substratum.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1.

25D-Owyhee silt loam, 8 to 12 percent slopes. This soil is in regularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Nyssa soils and about 5 percent Nyssa silt loam, gravel substratum.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-4.

25E-Owyhee silt loam, 12 to 20 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Nyssa soils and about 5 percent Nyssa silt loam, gravel substratum.

Runoff is rapid, and the hazard of erosion is severe. Capability unit VIe-2.

Poden series

The Poden series consists of well drained and moderately well drained soils that formed on flood plains and low fans in medium textured recent alluvium Slopes are. 0 to 2 percent. Elevation is 2,400 to 2,600 feet. The native vegetation was giant wildrye, Sandberg bluegrass, big sagebrush, rabbitbrush, and annual forbs. Average annual precipitation is 8 to 11 inches, average annual air temperature is 47 degrees to 52 degrees F, and the frost-free period is 120 to 140 days.

In a representative profile, the surface layer is grayish brown silt loam about 13 inches thick. The subsoil is grayish brown silt loam about 9 inches thick The upper part of the substratum, to a depth of 30 inches, is grayish brown heavy silt loam, and the lower part is multicolored very gravelly sand to a depth of 50 inches. The soil is moderately alkaline throughout.

Permeability is moderate in the upper part and very rapid in the very gravelly sand. Available water capacity is 4 to 8 inches. Effective rooting depth is 40 inches or more. A seasonal water table is at a depth of 4 to 6 feet during the irrigation period. Rare flooding occurs during spring runoff.

These soils are used for irrigated corn, potatoes, small grain, alfalfa hay, pasture, and wildlife habitat.

Representative profile of Poden silt loam about 40 feet north of a concrete irrigation control structure, NE1/4SW1/4SW1/4 section 7, T. 20 S., R. 42 E.:

Ap-0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; moderate thin platy structure parting to moderate fine granular; soft, very friable, nonsticky and slightly plastic; many fine roots; many very fine irregular pores; moderately alkaline; abrupt smooth boundary.

A12-7 to 13 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many roots; many very fine tubular pores; moderately alkaline; gradual wavy boundary.

B2-13 to 22 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; moderately alkaline; gradual wavy boundary.

C1-22 to 30 inches; grayish brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable, sticky and plastic; many roots; few fine tubular pores; moderately alkaline; clear wavy boundary.

IIC2-30 to 50 inches; multicolored very gravelly sand; single grained; loose; few roots in the upper few inches; many irregular pores; moderately alkaline.

The solum is silt loam, loam, or light silty clay loam Content of clay ranges from 18 to 35 percent but is generally less than 25 percent. Depth to very gravelly sand generally is 17 to 32 inches but ranges from 15 to 40 inches.

26-Poden silt loam. This soil is in irregularly shaped areas.

Included with this soil in mapping were as much as about 10 percent Powder soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIs-1.

Powder series

The Powder series consists of well drained soils that formed on bottom lands and fans in medium textured alluvium. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was bluebunch wheatgrass, giant wildrye, and big sagebrush. Average annual precipitation is 8 to 11 inches, average annual air temperature is 48 degrees to 52 degrees F, and the frost-free period is 130 to 170 days.

In a representative profile, the surface layer is grayish brown silt loam about 13 inches thick The subsoil is grayish brown and light brownish gray silt loam about 20 inches thick. The substratum is light brownish gray silt loam to a depth of 60 inches. The soil is mildly alkaline above a depth of 33 inches and moderately alkaline below a depth of 33 inches.

Permeability is moderate. Available water capacity is 12 to 15 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated onions, potatoes, sugar beets, small grain, alfalfa hay, and wildlife habitat.

Representative profile of Powder silt loam in the NW1/4SW1/4 section 36, T. 18 S., R. 44 E.:

Ap-0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; many tine roots; many fine irregular pores; mildly alkaline; abrupt smooth boundary.

A12-8 to 13 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; many fine roots; many fine tubular pores; mildly alkaline; gradual wavy boundary.

B21-13 to 21 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; many fine roots; many fine tubular pores; mildly alkaline; gradual wavy boundary.

B22-21 to 33 inches; light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, friable, sticky and plastic; few fine roots; many fore tubular pores; mildly alkaline; gradual wavy boundary.

C-33 to 60 inches; light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, sticky and plastic; very few roots; few large tubular pores; moderately alkaline.

The A and B21 horizons have a chroma of 2 and 3 when dry and moist. They are silt loam or loam. In some pedons contrasting texture is below a depth of 40 inches and gravel is below a depth of 50 inches.

27-Powder silt loam. This soil is in irregularly shaped areas on alluvial bottom lands.

Included with this soil in mapping were about 5 percent Kimberly soils, about 5 percent Poden soils, and about 5 percent Umapine soils.

Flooding occurs rarely on this soil. Runoff is slow, and the hazard of erosion is slight. Capability unit I-1.

Quincy series

The Quincy series consists of excessively drained soils that formed in moderately coarse textured eolian or alluvial material on terraces that have ridged, hummocky, or duny micro-relief. Slopes are 0 to 5 percent. Elevation is 2,100 to 2,500 feet. The native vegetation was needlegrass, Indian ricegrass, shadscale, and rabbitbrush. Average annual precipitation is 8 to 10 inches, average annual air temperature is 50 degrees to 53 degrees F, and the frost-free period is 150 to 180 days.

In a representative profile, the surface layer is dark brown loamy fine sand about 12 inches thick. The underlying material is brown loamy fine sand to a depth of 60 inches. The soil is moderately alkaline throughout.

Permeability is rapid. Available water capacity is 3 to 6 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated small grain, potatoes, alfalfa seed, alfalfa hay, and wildlife habitat.

Representative profile of Quincy loamy fine sand, 0 to 2 percent slopes, about 800 feet north of corner, 40 feet east of the road, SW1/4SW1/4 section 19, T. 16 S., R. 48 E.:

C1-0 to 12 inches; dark brown (10YR 4/3) loamy fine sand, dark brown (10YR 3/3) moist; single grained; loose, nonsticky and nonplastic; many fine roots; many fine irregular pores; moderately alkaline; gradual wavy boundary.

C2-12 to 60 inches; brown (10YR 5/3) loamy fine sand, very dark grayish brown (10YR 3/2) moist; single grained; loose, nonsticky and nonplastic; many fine roots above 18 inches, few fine roots below 18 inches; many fine irregular pores; moderately alkaline.

The C horizon has a hue of 10YR or 2.5Y, a value of 4 to 7 when dry and 3 or 4 when moist, and a chroma of 2 or 3 when dry and moist. Texture of the 10- to 40-inch control section ranges from sand to loamy fine sand. Depth to bedrock is more than 60 inches.

28A-Quincy loamy fine sand, 0 to 2 percent slopes. This soil is in irregularly shaped areas on low terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Feltham soils, about 5 percent Cencove soils, and about 5 percent Feltham Variant loamy fine sand.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Capability unit IIIs-5.

28B-Quincy loamy fine sand, 2 to 5 percent slopes. This soil is in irregularly shaped areas on low terraces.

Included with this soil in mapping were about 10 percent Feltham soils, about 5 percent Cencove soils, and about 5 percent Feltham Variant loamy fine sand.

Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Capability unit IIIs-5.

Riverwash

29-Riverwash. These miscellaneous areas consist of loose sand, gravel, cobblestones, and stones in or near stream beds or overflow channels below the annual high watermark. These areas are under flowing water once or twice each year and may be stripped or filled by any flood.

Most riverwash is barren, but in places some sagebrush and annual grasses grow. Capability unit VIIIw-1.

Sagehill series

The Sagehill series consists of well drained soils that formed on terraces in moderately coarse textured material over old lacustrine materials. Slopes are 0 to 20 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was needlegrass, Indian ricegrass, shadscale, and rabbitbrush. Average annual precipitation is 8 to 10 inches, average annual air temperature is 50 degrees to 54 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is light brownish gray fine sandy loam about 9 inches thick. The subsoil is pale brown fine sandy loam 7 inches thick. The upper part of the substratum is pale brown and very pale brown fine sandy loam to a depth of 32 inches, and the lower part is very pale brown, laminated very fine sandy loam to a depth of 60 inches. The soil is moderately alkaline in the upper 24 inches and strongly alkaline below a depth of 24 inches.

Permeability is moderate. Available water capacity is 5 to 6 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated onions, potatoes, sugar beets, small grain, alfalfa seed, alfalfa hay, and wildlife habitat.

Representative profile of Sagehill fine sandy loam, 0 to 2 percent slopes, about 40 feet north of the road on the center line, SE1/4SE1/4SW1/4 section 24, T. 20 S., R. 46 E.:

Ap-0 to 9 inches; light brownish gray (10YR 6/2) fine sandy loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; many fine tubular and irregular pores; moderately alkaline; abrupt smooth boundary.

B2-9 to 16 inches; pale brown (10YR 6/3) fine sandy loam, dark brown to brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; many fine tubular and irregular pores; moderately alkaline; gradual wavy boundary.

C1-16 to 24 inches; pale brown (10YR 6/3) fine sandy loam, dark brown to brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many fine roots many fine tubular pores; moderately alkaline; gradual wavy boundary.

C2ca-24 to 32 inches; very pale brown (10YR 7/3) fine sandy loan, dark brown to brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; many fine roots; many fine tubular pores; moderately calcareous; strongly alkaline; abrupt smooth boundary.

IIC3ca-32 to 60 inches; very pale brown (10YR 8/3) very fine sandy loam, very pale brown (10YR 7/3) moist; laminated sediments; soft, very friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; strongly calcareous; strongly alkaline.

The A and B horizons have a value of 5 or 6 when dry and 3 to 4 when moist and a chroma of 2 or 3 when dry and moist. The C and Cca horizons have a value of 6 to 8 when dry and 4 to 7 when moist and a chroma of 2 or 3 when dry and moist. The IIC horizon is very fine sandy loam or silt loam and is laminated into layers 1/16 to 1/4 inch thick. The depth to the laminated sediments ranges from about 20 to 35 inches. In places, the laminae have weakly cemented, extremely thin (less than 1 mm), dense and brittle crusts of calcium carbonate or silica, or both, that may be pink, brown, or reddish brown below a root mat. This cementation or glazing is discontinuous, is in the upper few inches of the laminations, and does not prevent the downward extension of roots.

30A-Sagehill fine sandy loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas on terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Truesdale soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIs-2.

30B-Sagehill fine sandy loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Truesdale soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is slow, and the erosion hazard is slight. Capability unit IIe-2.

30C-Sagehill fine sandy loam, 5 to 8 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Truesdale soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is slow, and the hazard of erosion is moderate. Capability unit IIIe-3.

30E-Sagehill fine sandy loam, 12 to 20 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 10 percent Truesdale soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is medium, and the hazard of erosion is high. Capability unit VIe-2.

Stanfield series

The Stanfield series consists of moderately well drained soils that formed in medium textured old alluvium on low terraces and bottom lands. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was saltgrass, giant wildrye, and greasewood. Average annual precipitation is 9 to 11 inches, average annual air temperature is 48 degrees to 54 degrees F, and the frost-free period is 120 to 170 days.

In a representative profile, the surface layer is very pale brown silt loam about 12 inches thick. The upper part of the underlying material, to a depth of 22 inches, is very pale brown silt loam, and the lower part is a silica- and calcium-cemented hardpan. The soil is very strongly alkaline throughout.

Permeability is moderate above the hardpan and very slow in the hardpan. Available water capacity is 2.5 to 7 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for irrigated and subirrigated pasture and wildlife habitat.

Representative profile of Stanfield silt loam about 3 miles southwest of Vale, SW1/4NE1/4SE1/4 section 2, T. 19 S., R. 44 E.:

Ap-0 to 8 inches; very pale brown (10YR 7/3) silt loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many fine roots; many fine tubular and irregular pores; strongly calcareous; very strongly alkaline; abrupt smooth boundary.

AC-8 to 12 inches; very pale brown (10YR 7/3) silt loam, dark brown to brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many fine roots; many fine tubular pores; strongly calcareous; very strongly alkaline; abrupt smooth boundary.

C1-12 to 22 inches; very pale brown (10YR 7/3) silt loam, dark brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and slightly plastic; common fine roots; few fine tubular pores; 10 to 20 percent calcium coated durinodes 1/4 to 3/4 inches in diameter; strongly calcareous; very strongly alkaline; abrupt smooth boundary.

C2casim-22 to 26 inches; very pale brown (10YR 7/3) strongly calcium and silica-cemented duripan, dark brown (l0YR 4/3) moist; strongly calcareous; very strongly alkaline.

The A, AC, and C horizons have a value of 5.5 to 7 when dry and 3.5 or 4 when moist and a chroma of 2 or 3 when dry and moist. They are silt loam or very fine sandy loam. The duripan ranges from strongly cemented to indurated but is indurated in some part in every pedon. Depth to the pan ranges from about 20 to 40 inches. The pan ranges from 4 to 30 inches in thickness, but it is generally 7 to 20 inches thick. In some pedons there is a series of pans with friable horizons between the pans.

31-Stanfield silt loam. This soil is in irregularly shaped areas on low terraces and bottom lands.

Included with this soil in mapping were about 10 percent Umapine soils and about 5 percent Powder soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IVw-1.

Truesdale series

The Truesdale series consists of well drained soils that formed on terraces in moderately coarse textured-material over old lacustrine sediments. Slopes are 0 to 12 percent. Elevation is 2,200 to 2,600 feet. The native vegetation was needlegrass, Sandberg bluegrass, big sagebrush, hopsage, and shadscale. Average annual precipitation is 9 to 11 inches, average annual air temperature is 50 degrees to 54 degrees F, and the frost-free period is 150 to 170 days.

In a representative profile, the surface layer is pale brown and brown fine sandy loam about 13 inches thick. The upper part of the underlying material is pale brown fine sandy loam to a depth of 26 inches, the middle part is white very fine sandy loam to a depth of 36 inches, and the lower part is a silica- and calcium-cemented hardpan. This soil is moderately alkaline throughout.

Permeability is moderately rapid above the hardpan and very slow in the hardpan. Available water capacity is 3 to 6 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for irrigated onions, potatoes, sugar beets, small grain, alfalfa seed, alfalfa hay, and wildlife habitat.

Representative profile of Truesdale fine sandy loam, 0 to 2 percent slopes, 2 1/2 miles south of Ontario, 50 feet west of water drop from the ditch going east, SE1/4SE1/4 section 29, T. 18 S., R. 47 E.:

Ap1-0 to 5 inches; pale brown (10YR 6/3) fine sandy loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; many fine tubular pores; moderately alkaline; abrupt smooth boundary.

Ap2-5 to 13 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and slightly plastic; many fine roots; many fine tubular pores; moderately alkaline; abrupt smooth boundary.

C1-13 to 26 inches; pale brown (10YR 6/3) fine sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and slightly plastic; many fine roots; many fine tubular pores; moderately alkaline; abrupt wavy boundary.

C2ca-26 to 36 inches; white (10YR 8/2) very fine sandy loam, pale brown (10YR 6/3) moist; massive; very hard, very friable, nonsticky and slightly plastic; few fine roots; few fine tubular pores; 10 to 20 percent durinodes 1/4 to 3/4 inch in diameter; strongly calcareous; moderately alkaline; gradual wavy boundary.

C3sicam-36 to 42 inches; pale brown (10YR 6/3) very fine sandy loam, yellowish brown (10YR 5/4) moist; white (10YR 8/2) coatings; massive; very hard, very firm, nonsticky and nonplastic; thin horizontal strongly lime-silica-cemented lenses 1/2 to 3 inches apart, concentrated in upper part; matrix very weakly cemented; few fine tubular pores; strongly calcareous; moderately alkaline.

The A horizon has a value of 5 or 6 when dry and 3 or 4 when moist and a chroma of 2 or 3. The C horizon has a value of 6, 7, or 8 when dry and 3 or 4 when moist. Chroma is 2, 3, or 4. Texture is fine sandy loam or coarse sandy loam. Depth to the duripan ranges from 20 to 40 inches but is generally about 30 inches. The duripan ranges from a strongly silica-lime-cemented horizon to a weakly lime-silica-cemented horizon. The weaker duripans have few very thin strongly cemented lenses in a very weakly cemented matrix containing 15 to 50 percent very hard nodules, some of which are durinodes.

32A-Truesdale fine sandy loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas on medium and high terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Sagehill soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIs-2.

32B-Truesdale fine sandy loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas on medium and high terraces.

Included with this soil in mapping were about 10 percent Sagehill soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-3.

32C-Truesdale fine sandy loam, 5 to 8 percent slopes. This soil is in irregularly shaped areas on medium and high terraces.

Included with this soil in mapping were about 10 percent Sagehill soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-3.

32D-Truesdale fine sandy loam, 8 to 12 percent slopes. This soil is in irregularly shaped areas on medium and high terraces.

Included with this soil in mapping were about 10 percent Sagehill soils, about 5 percent Cencove soils, and about 5 percent Nyssa soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-2.

Turbyfill series

The Turbyfill series consists of well drained soils that formed on bottom lands and fans in mixed, moderately coarse textured alluvium. Slopes are 0 to 5 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was Sandberg bluegrass, giant wildrye, and big sagebrush. Average annual precipitation is 8 to 11 inches, average annual air temperature is 47 degrees to 52 degrees F, and the frost-free period is 120 to 160 days.

In a representative profile, the surface layer is pale brown fine sandy loam about 6 inches thick. The underlying material is pale brown and very pale brown fine sandy loam to a depth of 60 inches. The soil is moderately alkaline throughout.

Permeability is moderately rapid. Available water capacity is 7 to 9 inches. Effective rooting depth is 60 inches or more.

These soils are used for irrigated onions, potatoes, sugar beets, small grain, alfalfa seed, alfalfa hay, and wildlife habitat.

Representative profile of Turbyfill fine sandy loam, 0 to 2 percent slopes, about 1,400 feet east and 60 feet north of section corner, SE1/4SW1/4 section 6, T. 21 S., R. 47 E.:

Ap-0 to 6 inches; pale brown (10YR 6/3) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine and coarse roots; many fine irregular and tubular pores; moderately alkaline; abrupt smooth boundary.

C1-6 to 20 inches; pale brown (10YR 6/3) fine sandy loam, very dark grayish brown (10YR 3/2).moist; massive; soft, very friable, nonsticky and nonplastic; many fine and coarse roots; many fine irregular and tubular pores; slightly calcareous; moderately alkaline; gradual wavy boundary.

C2ca-20 to 37 inches; pale brown (10YR 6/3) fine sandy loam, dark brown to brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; many fine and coarse roots; many fine irregular and tubular pores; strongly calcareous; moderately alkaline; gradual wavy boundary.

C3ca-37 to 60 inches; very pale brown (10YR 7/3) fine sandy loam, dark brown to brown (10YR 4/3) moist; single grained; soft, very friable, nonsticky and nonplastic; few fine roots; many fine irregular pores; strongly calcareous; moderately alkaline.

The A horizon has a value of 5 to 6 when dry and 3 to 5 when moist and a chroma of 2 to 3 when dry and moist. It is fine sandy loam or sandy loam that is less than 18 percent clay and less than 15 percent coarse fragments. It is noncalcareous to moderately calcareous and is neutral to moderately alkaline. The C1 horizon is moderately to strongly calcareous and moderately alkaline. The Cca horizon has accumulations of carbonates but contains less than 15 percent in any layer at least 6 inches thick, and it is not cemented.

33A-Turbyfill fine sandy loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas on bottom lands. It has the profile described as representative of the series.

Included with this soil in mapping were about 10 percent Garbutt soils, about 5 percent Quincy soils, and about 5 percent Cencove soils.

Runoff is slow, and the hazard of erosion is moderate. Capability unit I-1.

33B-Turbyfill fine sandy loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas on bottom lands.

Included with this soil in mapping were about 10 percent Garbutt soils, about 5 percent Quincy soils, and about 5 percent Cencove soils.

Runoff is slow, and the hazard of erosion is moderate. Capability unit IIe-2.

Umapine series

The Umapine series consists of somewhat poorly drained soils that formed on bottom lands and low terraces in medium textured old alluvium. Slopes are 0 to 2 percent. Elevation is 2,100 to 2,600 feet. The native vegetation was saltgrass, giant wildrye, and greasewood. Average annual precipitation is 9 to 11 inches, average annual air temperature is 48 degrees to 54 degrees F, and the frost-free period is 120 to 170 days.

In a representative profile, the surface layer is pale brown silt loam about 11 inches thick. The upper part of the underlying material, to a depth of 23 inches, is very pale brown silt loam, and the lower part is light gray silt loam to a depth of 60 inches. The soil is very strongly alkaline above a depth of 6 inches, strongly alkaline between depths of 6 and 23 inches, and moderately alkaline below a depth of 23 inches.

Permeability is moderately slow. Available water capacity is 7 to 12 inches. Effective rooting depth is 60 inches or more. A seasonal water table is at a depth of 2 to 5 feet in winter and spring. Rare flooding occurs during spring runoff.

These soils are used for irrigated small grain, alfalfa hay, pasture, and wildlife habitat.

Representative profile of Umapine silt loam about 20 feet northeast of 1/16 corner SE1/4NE1/4 section 1, T. 19 S., R. 44 E.:

A11-0 to 2 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft, very friable, nonsticky and plastic; many fine and coarse roots; many fine round pores; strongly calcareous; very strongly alkaline; abrupt smooth boundary.

A12-2 to 6 inches; pale brown (10YR 6/3) silt loam, dark brown to brown (10YR 4/3) moist; strong thin platy structure; soft, very friable, slightly sticky and plastic; many fine and coarse roots; many fine tubular pores; strongly calcareous; very strongly alkaline; abrupt smooth boundary.

A13-6 to 11 inches; pale brown (10YR 6/3) silt loam, dark brown to brown (10YR 4/3) moist; moderate thick platy structure; soft, very friable, slightly sticky and plastic; many fine and coarse roots; many fine tubular pores; strongly calcareous; strongly alkaline; gradual wavy boundary.

C1-11 to 23 inches; very pale brown (10YR 7/3) silt loam, dark brown to brown (10YR 4/3) moist; weak coarse prismatic structure; soft, very friable, slightly sticky and plastic; many fine and coarse roots; many fine tubular pores; strongly calcareous; strongly alkaline; abrupt smooth boundary.

C2-23 to 30 inches; light gray (10YR 7/2) silt loam, dark brown (10YR 3/3) moist; massive; hard, friable, slightly sticky and plastic; few fine roots; few fine tubular pores; 50 percent rounded 1/4- to 1/2inch silica- and calcium-cemented nodules; strongly calcareous; moderately alkaline; gradual wavy boundary.

C3-30 to 60 inches; light gray (10YR 7/2) silt loam, dark brown (10YR 3/3) moist; massive; hard, friable, slightly sticky and plastic; few fine roots; few fine tubular pores; strongly calcareous; moderately alkaline.

The A horizon has a value of 5 or 6 when dry and 4 or 5 when moist and a chroma of 2 to 3. It is silt loam, very fine sandy loam, or fine sandy loam. The upper 40 inches is moderately to very strongly alkaline. Content of exchangeable sodium exceeds 15 percent in the upper 20 inches. These soils are calcareous in all parts between depths of 10 and 20 inches.

34-Umapine silt loam. This soil is in irregularly shaped areas on bottom lands and low terraces.

Included with this soil in mapping were about 10 percent Stanfield soils and about 5 percent Powder soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIw-1.

Virtue series

The Virtue series consists of well drained soils that formed on terraces in medium textured old alluvial material over a cemented hardpan. Slopes range from 0 to 20 percent but are generally less than 8 percent. Elevation is 2,300 to 2,600 feet. The native vegetation was bluebunch wheatgrass, Sandberg bluegrass, and big sagebrush. Average annual precipitation is 9 to 11 inches, average annual air temperature is 48 degrees to 52 degrees F, frost-free period is 110 to 170 days.

In a representative profile, the surface layer is light brownish gray and pale brown silt loam about 14 inches thick. The subsoil is yellowish brown silty clay loam about 12 inches thick. An indurated, silica-lime hardpan is at a depth of about 26 inches. The soil is neutral in the upper 5 inches, mildly alkaline between depths of 5 and 24 inches, and moderately alkaline below a depth of 24 inches.

Permeability is moderately slow. Available water capacity is 5 to 8.5 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for irrigated small grain, alfalfa seed, alfalfa hay, occasional row crops, and wildlife habitat.

Representative profile of Virtue silt loam, 0 to 2 percent slopes, about 400 feet west of gravel pit, 200 feet south of fence, NW1/4NW1/4 section 12, T. 17 S., R. 43 E.:

A1-0 to 5 inches; light brownish gray (10YR 6/2) silt loam, dark brown (10YR 3/3) moist; moderate fine to medium platy structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; neutral abrupt smooth boundary.

A3-5 to 14 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many fine roots; many fine tubular pores; mildly alkaline; clear smooth boundary.

B21t-14 to 19 inches; yellowish brown (10YR 5/4) silty clay loam, dark brown (10YR 4/3) moist; light gray (10YR 7/2) coatings; moderate medium prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic; few coarse roots; few fine tubular pores; few thin clay films on surfaces of peds and in pores; mildly alkaline; clear wavy boundary.

B22t-19 to 24 inches; yellowish brown (10YR 5/4) silty clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few coarse roots; few fine tubular pores; few thin clay films on surfaces of peds and in pores; mildly alkaline; clear wavy boundary.

B3t-24 to 26 inches; yellowish brown (10YR 5/4) silty clay loam, dark (10YR 4/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; very few fine roots; very few fine tubular pores; weakly calcareous; moderately alkaline; abrupt wavy boundary.

Ccasim-26 to 27 inches; very pale brown (10YR 7/3), brown (10YR 5/3) moist; platy; indurated plates with weakly cemented calcareous loam between plates; strongly calcareous; moderately alkaline.

The A horizon has a value of 5 to 6 when dry. It is silt loam or very fine sandy loam. The Bt horizon is silty clay loam and is 27 to 35 percent clay. Depth to the duripan ranges from 20 to 40 inches but generally is 22 to 30 inches. Stratified gravel and sand occurs under the duripan in most areas.

35A-Virtue silt loam, 0 to 2 percent slopes. This soil is in irregularly shaped areas on terraces. It has the profile described as representative of the series.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Frohman soils, about 5 percent Malheur soils, and about 2 percent Chilcott soils.

Runoff is medium, and the erosion hazard is slight. Capability unit IIIs-1.

35B-Virtue silt loam, 2 to 5 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Frohman soils, about 5 percent Malheur soils, and about 2 percent Chilcott soils.

Runoff is medium, and the erosion hazard is moderate. Capability unit IIIe-4.

35C-Virtue silt loam, 5 to 8 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Frohman soils, about 5 percent Malheur soils, and about 2 percent Chilcott soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4.

35D-Virtue silt loam, 8 to 12 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Frohman soils, about 5 percent Malheur soils, and about 2 percent Chilcott soils.

Runoff is medium, and the erosion hazard is moderate. Capability unit IVe-3.

35E-Virtue silt loam, 12 to 20 percent slopes. This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were about 5 percent Nyssa soils, about 5 percent Frohman soils, about 5 percent Malheur soils, and about 2 percent Chilcott soils.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIe-1.

Xeric Torriorthents

36E-Xeric Torriorthents, moderately steep. These soils consist of exposed lacustrine material from the Payette, Idaho, and similar geologic formations. Slopes are 5 to 20 percent. Geological erosion is severe and has created badlands in some of the softer materials.

Most of this mapping unit is nearly barren of vegetation. Capability unit VIIIe-1.

36F-Xeric Torriorthents, very steep. These soils consist of gravelly and silty alluvium that is variable in characteristics. Slopes are 20 to 60 percent. Areas are along sidewalls on terrace scarps.

Most of this mapping unit is nearly barren of vegetation. The sparse vegetation consists of hopsage, desert shrubs, and annual weeds and grasses. Capability unit VIIIe-1.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area-the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others.

Soil erosion is a major problem on cropland and pasture in the survey area. If slope is more than 2 percent, erosion is a hazard. Feltham, Frohman, Nyssa, and Owyhee soils, for example, have slopes of 2 to 20 percent.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils with a clayey subsoil, such as Greenleaf, Malheur, and Virtue soils, and on soils with a layer in or below the subsoil that limits the depth of the root zone. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves quality of water for municipal use, for recreation, and for fish and wildlife.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps plant cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land and also provide nitrogen and improve tilth for the following crop.

Soil blowing is a hazard on the sandy Feltham and Quincy soils. Soil blowing can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining plant cover, surface mulch, or a rough surface through proper tillage minimizes soil blowing on these soils. Windbreaks of adapted shrubs are effective in reducing soil blowing on the sandy soils.

Information for the design of erosion control practices for each kind of soil is available from local offices of the Soil Conservation Service.

Soil drainage is the major management need on some of the acreage used for crops and pasture in the survey area. Some soils are naturally so wet that the production of crops common to the area is generally not possible. These are poorly drained and very poorly drained Baldock and Umapine soils, which make up about 25,750 acres of the survey area.

Soil fertility is naturally high in most soils of the uplands in the survey area. All soils are naturally neutral or alkaline. The soils on flood plains, such as Powder, Harana, Stanfield, and Umapine soils, range from slightly alkaline to very strongly alkaline and are naturally higher in plant nutrients than most upland soils.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous. Most of the soils used for crops in the survey area have a silt loam surface layer that is light in color and low in content of organic matter. Generally the structure of such soils is weak, and rainfall causes a crust to form on the surface. The crust is hard when dry, and it is nearly impervious to water. Once the crust forms, it reduces infiltration and increases runoff. Regular additions of crop residue, manure, and other organic material can help to improve soil structure and to reduce crust formation.

The dark-colored Harana soils are clayey, and tilth is a problem because the soils often stay wet until late in spring. If plowed when wet, they tend to be very cloddy when dry, so a good seedbed is difficult to prepare. Plowing in fall generally results in good tilth in spring.

Field crops suited to the soils and climate of the survey area include many that are not now commonly grown. Sugar beets, onions, potatoes, and corn are the row crops. Wheat, barley, and alfalfa hay are the common close-growing crops. Rye, oats, buckwheat, and flax could be grown, and grass seed could be produced from tall wheatgrass, tall fescue, and orchardgrass.

Special crops grown commercially in the survey area are vegetables, small fruits, and nursery plants. A small acreage throughout the county is used for melons, strawberries, sweet corn, tomatoes, and other vegetables and small fruits. In addition, large areas can be adapted to other special crops such as grapes and many vegetables. Apples and peaches are the most important tree fruits grown in the county.

Capability classification

Capability classification shows, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability unit is identified in the description of each soil map unit in the section "Descriptions of the soils." Capability units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6.

In the following pages, each capability unit in the survey area is discussed and suggestions are given for the use and management of the soils in each unit. The names of soil series represented in each capability unit are named in the description of that unit, but this does not mean that all soils of a given series are in that unit.

Capability unit I-1

This capability unit consists of Garbutt, Greenleaf, Kimberly, Owyhee, Powder, and Turbyfill soils. These are well drained silt loams and fine sandy loam. Slopes are 0 to 2 percent. Annual precipitation is 7 to 11 inches. The frost-free period is 130 to 170 days.

Permeability is moderately rapid to moderately slow. Available water capacity is 6 to 15 inches. Typically, roots penetrate 40 to 60 inches or more. The organic matter content is low to moderately low. Runoff is slow, and the hazard of erosion is slight.

These soils are used for irrigated row crops (fig. 3), small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems.

Continuous row cropping is feasible on these soils if commercial fertilizer is used and organic matter content is maintained by plowing down crop residue. Suitable crops include beets, potatoes, grain, corn, and onions alone or in combination. Less intensive cropping systems which include small grain and grass and legumes are also suitable.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. In surface irrigation, the length of runs will vary with texture of the surface layer. Corrugations commonly are used for close-growing crops, and furrows are used for row crops (fig. 4). Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult.

Capability unit IIe-1

Bully silt loam is the only soil in this capability unit. It is well drained. Slopes are 0 to 2 percent. Annual precipitation is 7 to 10 inches. The frost-free period is 120 to 150 days.

Permeability is moderate. Available water capacity is 10 to 12.5 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, but the hazard of erosion is moderate to severe because of the light weight of the soil and its tendency to undercut and gully.

This soil is used for irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa hay for 4 to 7 years and an annual crop, such as potatoes, small grain, or corn, for 4 or 5 years. Another suitable cropping system is alfalfa and grass for hay and pasture for 3 to 5 years, then corn, potatoes, and small grain.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Rate of water application is critical because of the light weight of this soil and its tendency to erode under large heads of water. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult.

Capability unit IIe-2

This capability unit consists of Garbutt, Greenleaf, Sagehill, Owyhee, and Turbyfill soils. These are well drained silt loams and fine sandy loams. Slopes are 2 to 5 percent. Annual precipitation is 8 to 10 inches. The frost-free period is 150 to 170 days.

Permeability is moderately rapid to moderately slow. Available water capacity is 5 to 12 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, and the hazard of erosion is slight to moderate.

These soils are used for irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system,

A suitable. cropping system is alfalfa and grass for hay or pasture for 2 to 5 years, corn or sugar beets for 2 to 3 years, and small grain for 1 to 3 years. Another suitable cropping system is alfalfa for 2 years, a row crop for 2 years, and small grain for 1 year.

Irrigation water can be applied by corrugations, furrows, or sprinklers. Runs should be short because of the hazard of erosion. These soils commonly can be leveled or smoothed for irrigation without damage.

Capability unit IIs-1

Poden silt loam is the only soil in this capability unit. This is a well drained silt loam underlain by very gravelly sand. Slopes are 0 to 2 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 110 to 140 days.

Permeability is moderate in the upper part of the profile and very rapid in the underlying very gravelly sand. Available water capacity is 4 to 8 inches. Typically, roots penetrate 40 inches or more. Runoff is slow, and the hazard of erosion is slight.

This soil is used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa hay for 4 to 7 years and an annual crop, such as potatoes, a small grain, or corn for 4 or 5 years. Another suitable cropping system is alfalfa and grass for hay or pasture for 3 to 5 years, then corn, potatoes, and small grain.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult.

Capability unit IIs-2

Sagehill fine sandy loam, 0 to 2 percent slopes, is the only soil in this capability unit. This soil is well drained. Slopes are 0 to 2 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 150 to 170 days.

Permeability is moderate. Available water capacity is 5 to 6 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

This soil is used for irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

Continuous row cropping is feasible on these soils if commercial fertilizer is used and organic matter content is maintained by plowing down crop residue. Suitable crops include beets, potatoes, grain, corn, and onions alone or in combination. Less intensive cropping systems which include small grain and grass and legumes are also suitable.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult.

Capability unit IIc-1

This capability unit consists of Harana soils. They are moderately well drained silt loams and silty clay loams. Slopes are 0 to 2 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 130 to 160 days.

Permeability is moderately slow. Available water capacity is 10 to 12 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

These soils are used for irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can by maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa hay for 4 to 7 years, and an annual crop, such as potatoes, small grain, or corn, for 4 or 5 years. Another suitable cropping system is alfalfa and grass for hay or pasture for 3 to 5 years, then corn, potatoes, and small grain.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult.

Capability unit IIIe-1

This capability unit consists of Malheur, Nyssa, and Owyhee soils. These soils are well drained silt loams underlain by a hardpan or by laminated sediments. Slopes are 2 to 8 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 140 to 170 days.

Permeability is moderate to moderately slow above the hardpan or laminated sediments. Available water capacity is 4 to 12 inches. Typically, roots penetrate 20 to 40 inches in the soils that have a hardpan and 60 inches or more in the soils underlain by laminated sediments. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

These soils are used for irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems.

A suitable cropping system is alfalfa and grass for hay for 3 to 7 years and corn or small grain for 2 years, followed by a new seeding of alfalfa.

Irrigation water can be applied by corrugations, furrows, and sprinklers (fig. 5). Runs should be short and streams should be small on these soils because of the hazard of erosion. These soils commonly can be leveled or smoothed for irrigation without damage. Soils that are less than 20 inches deep over a hardpan after land smoothing or leveling should be subsoiled to assure a uniform rooting depth throughout the field.

Capability unit IIIe-2

This capability unit consists of Nyssa soils. These are well drained silt loams that have a hardpan and a very gravelly sand substratum beneath the hardpan. Slopes are 2 to 8 percent. Annual precipitation is 8 to 10 inches. The frost-free period is 150 to 170 days.

Permeability is moderate above the hardpan. Available water capacity is 4 to 8 inches. Typically, roots penetrate 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight to moderate.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa and grass for hay for 3 to 7 years and corn or small grain for 2 years, followed by a new seeding of alfalfa.

Irrigation water can be applied by corrugations, furrows, and sprinklers. Runs should be short and streams should be small on these soils because of the hazard of erosion. These soils commonly can be leveled or smoothed for irrigation. Deep cuts expose the very gravelly sand substratum in places.

Capability unit IIIe-3

This capability unit consists of Cencove, Feltham, Sagehill, and Truesdale soils. These are well drained and excessively drained fine sandy loams underlain by a hard, pan, stratified sediments, laminated sediments, or a very gravelly sand substratum. Slopes are 2 to 8 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 150 to 170 days.

Permeability is moderately rapid above the hardpan and above the very gravelly sand substratum, rapid above the stratified sediments, and moderate above the laminated sediments. Available water capacity is 3 to 6 inches. Typically, roots penetrate 20 to 40 inches in the soils that have a hardpan or a very gravelly sand substratum and 60 inches or more in the soils that are underlain by stratified or laminated sediments. Runoff is slow to moderate, and the hazard of erosion is slight to moderate.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa and grass for hay for 3 to 7 years and corn or small grain for 2 years followed by a new seeding of alfalfa.

Irrigation water can be applied by corrugations, furrows, and sprinklers. Runs should be short and streams should be small on these soils because of the hazard of erosion. These soils commonly can be leveled or smoothed for irrigation without damage. Soils that are less than 20 inches deep over a hardpan after leveling or smoothing should be subsoiled to assure a uniform rooting depth throughout the field. On soils that have a very gravelly sand substratum, deep cuts should be avoided in leveling or additional cover material should be provided for backfilling.

Capability unit IIIe-4

This capability unit consists of Chilcott and Virtue soils. These are well drained silt loams that have a silty clay or silty clay loam subsoil over a hardpan. Slopes are 2 to 8 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 110 to 170 days.

Permeability is moderately slow to slow above the hardpan. Available water capacity is 3 to 8.5 inches. Typically, roots penetrate 20 to 40 inches. Runoff is medium, and the hazard of erosion is slight to moderate.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is legumes and grass for 3 to 8 years and small grain for 1 to 2 years.

Irrigation water can be applied by corrugations, furrows, and sprinklers. Runs should be short and streams should be small on these soils because of the hazard of erosion. These soils commonly can be leveled or smoothed for irrigation. In places, deep cuts expose stratified sand and gravel deposits that underlie the hardpan. Deep plowing to mix the subsoil and the surface layer is beneficial in most places.

Capability unit IIIw-1

This capability unit consists of Baldock and Umapine soils. These are somewhat poorly drained silt loams. Slopes are 0 to 2 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 120 to 170 days.

Permeability is moderate to moderately slow. Available water capacity is 7 to 12 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

These soils are used for hay, pasture, and wildlife habitat.

The soils in this unit are moderately to very strongly saline and alkaline. If drained and leached of salts and alkali, the soils in this unit are well suited to irrigated corn, sugar beets, potatoes, onions, small grains, alfalfa and grasses.. During early stages of reclamation, tall wheatgrass, barley, or sugar beets can be grown.

Practices are needed to drain the soils, to maintain fertility and organic matter content, and to leach harmful salts and alkali. All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems.

Continuous row cropping is feasible on these soils if commercial fertilizer is used and organic matter content is maintained by plowing down crop residue. Less intensive cropping systems which include small grains and grass and legumes are also suitable.

Irrigation water can be applied by borders, corrugations, and furrows. The length of runs varies according to texture of the surface layer. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult.

Capability unit IIIs-1

This capability unit consists of Malheur, Nyssa, and Virtue soils. These are well drained silt loams underlain by a hardpan. Slopes are 0 to 2 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 110 to 170 days.

Permeability is moderate to moderately slow above the hardpan. Available water capacity is 4 to 8.5 inches. Typically, roots penetrate 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems. Organic matter content can be maintained or increased by plowing down crop residue.

A suitable cropping system is alfalfa and grass for hay or pasture for 5 to 7 years, corn or sugar beets for 2 to 4 years, and small grain for 1 to 3 years. Another suitable cropping system is alfalfa for 2 years, a row crop for 2 years, and small grain for 1 year.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult. In places, deep cuts expose stratified sand and gravel deposits that underlie the hardpan. Deep plowing of the Malheur and Virtue soils to mix the subsoil and the surface layer is beneficial in most places (fig. 6).

Capability unit IIIs-2

This capability unit consists of Nyssa and Truesdale soils. These are well drained silt loams and fine sandy loams that have a hardpan and a very gravelly sand substratum beneath the hardpan. Slopes are 0 to 2 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 150 to 170 days.

Permeability is moderate to moderately rapid above the hardpan. Available water capacity is 3 to 8 inches. Typically, roots penetrate 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

Row cropping is feasible on these soils if commercial fertilizer is used and organic matter content is maintained by plowing down crop residue. Suitable crops include sugar beets, potatoes, grain, corn, and onions alone or in combination. Less intensive cropping systems which include small grains and grass and legumes are also suitable.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. The length of runs vary according to the texture of the surface layer. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because these soils are nearly level, preparation for irrigation is not difficult. In places, deep cuts expose stratified sand and gravel deposits that underlie the hardpan.

Capability unit IIIs-3

This capability unit consists of Harana and McLoughlin soils. These are moderately well drained and well drained silty clay loams and silt loams. Slopes are 0 to 2 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 120 to 170 days.

Permeability is moderately slow. Available water capacity is 8 to 12 inches. Typically, roots penetrate 60 inches or more. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

The soils in this unit are moderately to very strongly saline and alkaline. If leached of salts and alkali, the soils in this unit are suited to irrigated corn, sugar beets, small grains, alfalfa, and grasses. During the early stages of reclamation, tall wheatgrass, barley, or sugar beets can be grown. During later stages, alfalfa, corn, small grain, and vegetables can be grown.

Practices are needed to maintain fertility and organic matter content and to leach harmful salts and alkali. All, crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

Continuous row cropping is feasible on these soils if commercial fertilizer is used and organic matter content is maintained by plowing down crop residue. Less intensive cropping systems which include small grains and grass and legumes are also suitable.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. Corrugations are commonly used for close-growing crops, and furrows are used for row crops. These soils commonly can be leveled or smoothed for irrigation without damage. Over-irrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop.

Capability unit III-s

This capability unit consists of McLoughlin soils. These are well drained silt loams. Slopes are 2 to 8 percent. Annual precipitation is 8 to 10 inches. The frost-free period is 120 to 170 days.

Permeability is moderately slow. Available water capacity is 8 to 12 inches. Typically, roots penetrate 60 inches or more. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

The soils are moderately to very strongly saline and alkaline. If leached of salts and alkali, the soils in this unit are suited to irrigated small grain, corn, alfalfa, and pasture. All crops respond to nitrogen and to phosphorus. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

Irrigation water can be applied by corrugations or furrows. Runs should be short and streams should be small on these soils because of the hazard of erosion. These soils commonly can be leveled or smoothed for irrigation without damage. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop.

Capability unit IIIs-5

This capability unit consists of Cencove, Feltham, Feltham Variant, and Quincy soils. These are well drained to excessively drained fine sandy loams, loamy fine sands, and sandy loams. Slopes are 0 to 8 percent. Annual precipitation is 7 to 10 inches. The frost-free period is 150 to 180 days.

Permeability is moderately rapid to rapid in the upper part of the profile and moderately rapid to very rapid in the lower part. Available water capacity is 3 to 8 inches. Roots penetrate 20 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system on the level soils is alfalfa and grass for 4 to 6 years, corn for 1 year, and small grain for 1 year. Another suitable system on the level soils is small grain for 2 years and potatoes for 1 year. Sloping soils should be kept in alfalfa and grass with an occasional crop of small grain to clean up the field.

Irrigating these soils is difficult because water intake is very rapid and large streams cause erosion. Irrigation water can be applied by sprinklers, corrugations, or furrows. Sprinklers can be used for all crops. If a surface irrigation system is used, runs should be short and streams should be small to reduce erosion. Some type of cover should be maintained through winter to reduce soil blowing.

Capability unit IVe-1

This capability unit consists of Frohman soils. These are well drained silt loams that are underlain by a hardpan. Slopes are 2 to 8 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 130 to 170 days.

Permeability is moderate above the hardpan. Available water capacity is 2 to 4 inches. Typically, roots penetrate 10 to 20 inches. Runoff is slow to moderate, and the hazard of erosion is slight to moderate.

These soils are used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

A suitable cropping system is legumes and grass for 3 to 8 years and small grain for 1 to 2 years.

Irrigation water can be applied by corrugations or sprinklers. Runs should be short and streams should be small on the sloping soils because of the hazard of erosion. These soils can be leveled or smoothed for irrigation, but gravelly material is at a depth of 20 to 40 inches in places and may be exposed by leveling. In most places, subsoiling to break the hardpan assures a uniform rooting depth and increases the water holding capacity of the soils.

Capability unit IVe-2

This capability unit consists of Cencove, Truesdale, and Feltham soils. These are well drained fine sandy loams that have a hardpan or a very gravelly sand substratum and sandy loams that have a loamy coarse sand substratum. Slopes are 8 to 12 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 150 to 170 days.

Permeability is mainly moderately rapid. Available water capacity is 3 to 6 inches. Roots penetrate 20 to 40 inches in the Cencove and Truesdale soils and 60 inches or more in the Feltham soils. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for irrigated small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa and grass for 3 to 7 years. and small grain for 1 year, followed by a new seeding of alfalfa.

Irrigating these soils is difficult because water intake is rapid and large streams cause erosion. Irrigation water can be applied by sprinklers or corrugations. Sprinklers can be used for all crops. If a surface irrigation system is used, runs should be short and streams should be small to reduce water erosion. Some type of cover should be maintained through winter to reduce soil blowing. These soils commonly can be leveled or smoothed for irrigation. In places, deep cuts expose stratified sand and gravel deposits.

Capability unit IVe-3

This capability unit consists of Chilcott, Frohman, Nyssa, and Virtue soils. These soils are well drained silt loams that have a hardpan. Slopes are 5 to 12 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 110 to 170 days.

Permeability is moderate to slow above the hardpan. Available water capacity is 2 to 8.5 inches. Typically, roots penetrate 10 to 40 inches. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for irrigated small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems.

A suitable cropping system is legumes and grass for 4 to 8 years and small grain for 1 to 2 years.

Irrigation water can be applied by corrugations or sprinklers. Runs should be small because of the hazard of erosion. These soils can be smoothed to control waterflow, but leveling is very difficult. In many places gravelly sandy material is below the hardpan and may be exposed by smoothing. Subsoiling is possible on Frohman and Nyssa soils to assure a uniform rooting depth; however, Virtue soils have a silty clay loam subsoil that reseals during irrigation, so subsoiling would become a yearly operation.

Capability unit IVe-4

This capability unit consists of Nyssa and Owyhee soils. These are well drained silt loams that have a hardpan or are underlain by laminated lacustrine sediments. Slopes are 8 to 12 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 150 to 180 days.

Permeability is moderate above the hardpan or the laminated sediments. Available water capacity is 4 to 12 inches. Typically, roots penetrate 20 to 40 inches in the soils that have a hardpan and 60 inches or more in the soils that are underlain by laminated sediments. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for irrigated small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa and grass for 5 to 7 years and small grain for 2 years, followed by a new seeding of alfalfa.

Irrigation water can be applied by corrugations or sprinklers. Runs should be short and streams should be small on the sloping soils because of the hazard of erosion. These soils commonly can be leveled or smoothed for irrigation without damage. Soils that are less than 20 inches deep over a hardpan after smoothing or leveling should be subsoiled to assure a uniform rooting depth throughout the field. These soils are suitable for deep cuts and fills.

Capability unit IVe-5

Only Feltham loamy fine sand, 8 to 12 percent slopes, is in this capability unit. It is excessively drained. Annual precipitation is 8 to 10 inches. The frost-free period is 150 to 170 days.

Permeability is rapid in the upper part of the profile and moderately rapid in the lower part. Available water capacity is 3 to 6 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

These soils are used for irrigated small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa and grass for 5 to 7 years and an occasional crop of small grain before reseeding.

Irrigating this soil is difficult because water intake is very rapid and large streams cause erosion. Irrigation water can be applied by sprinklers or corrugations. Sprinklers can be used for all crops. If a surface irrigation system is used, runs should be short and streams should be small to reduce water erosion. Some type of cover should be maintained through winter to reduce soil blowing.

Capability unit IVw-1

This capability unit consists of Ahtanum, Otoole, and Stanfield soils. These are somewhat poorly drained silt loams that have a hardpan. They are strongly saline-alkali. Slopes are 0 to 2 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 110 to 170 days.

Permeability is moderate above the hardpan. Available water capacity is 1.5 to 7 inches. Typically, roots penetrate 10 to 40 inches. Runoff is slow, and the hazard of erosion is slight.

These soils are used for hay, pasture, and wildlife habitat.

If leached of harmful salts and alkali, these soils can be used for crops. Tall wheatgrass and other alkali-tolerant grasses should be continuously grown during the early stages of reclamation. Alfalfa and sugar beets grow well on soils that have been reclaimed. Crops respond well to nitrogen and phosphorus fertilizer.

The soils in this unit are difficult to reclaim, and drainage systems must be carefully maintained. Use of soil amendments such as gypsum or sulfur and deep subsoiling to increase rooting depth and shatter the hardpan facilitate the removal of salts and alkali. Organic matter content can be maintained or increased by use of legumes and grasses.

Irrigation water can be applied by borders, corrugations, furrows, and sprinklers. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop.

Capability unit IVw-2

This capability unit consists of Notus and Falk Variant soils. These are moderately well drained and somewhat poorly drained coarse sandy loams and fine sandy loams that are underlain by very gravelly sand or very gravelly loamy coarse sand. Slopes are 0 to 2 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 120 to 170 days.

Permeability is moderately rapid in the upper part of the profile and very rapid in the underlying gravelly sandy material. Available water capacity is 2 to 6 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

These soils are used for some irrigated row crops, alfalfa hay, small grain, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems.

A suitable cropping system is alfalfa and grass hay for 5 to 7 years and small grain for 1 to 2 years.

Irrigation water can be applied by corrugations, furrows, borders, or sprinklers. Irrigation runs will be short because of the rapid permeability in the substratum. These soils are subject to overflow during spring runoff and must be protected if leveled. These soils can be smoothed and leveled. Gravel and cobblestones are in the soil in places and may be exposed by leveling. A high water table occurs in spring and reduces rooting depth for some crops. Subirrigation can increase saline-alkali content of the soils if continued for many years without surface irrigation.

Capability unit IVs-1

Only Frohman silt loam, 0 to 2 percent slopes, is in this capability unit. It is well drained and has a hardpan. Slopes are 0 to 2 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 130 to 170 days.

Permeability is moderate above the hardpan. Available water capacity is 2 to 4 inches. Typically, roots penetrate 10 to 20 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems.

A suitable cropping system is alfalfa and grass for hay or pasture for 5 to 7 years and corn or small grain for 1 to 2 years, followed by a new seeding of alfalfa.

Irrigation water can be applied by borders, corrugations, furrows, or sprinklers. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because this soil is nearly level, preparation for irrigation is not difficult. Gravelly material is below the hardpan and may be exposed by deep cuts. Subsoiling to shatter the hardpan assures uniform rooting depth for plants.

Capability unit IVs-2

Only Kiesel silt loam is in this capability unit. This well drained soil has a silty clay subsoil. Slopes are 0 to 2 percent. Annual precipitation is 9 to 11 inches. The frost-free period is 150 to 170 days.

Permeability is slow. Available water capacity is 7 to 9 inches. Typically, roots penetrate 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

This soil is used for irrigated hay, pasture, and wildlife habitat.

The soil is strongly to very strongly saline and alkaline. If drained and leached of salts and alkali, the soil in this unit is suited to irrigated alfalfa and grass hay, sugar beets, and small grain. During early stages of reclamation, tall wheatgrass, barley, or sugar beets can be grown. During later stages, alfalfa, corn, and small grain can be grown.

Practices are needed to adequately drain the soil, to maintain fertility and organic matter content, and to leach harmful salts and alkali. All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping systems.

A suitable cropping system on reclaimed soil is legumes and grass hay or pasture for 3 to 5 years, sugar beets or corn for 2 to 4 years, and small grain for 2 to 5 years.

Irrigation water can be applied, by borders, corrugations, and furrows. Corrugations commonly are used for close-growing crops, and furrows are used for row crops. Overirrigation can be avoided by applying only enough water to wet the soil evenly to the rooting depth of the crop. Because this soil is nearly level, preparation for irrigation is not difficult.

Capability unit IVs-3

Only Feltham Variant loamy fine sand is in this capability unit. This soil is excessively drained and is underlain by very gravelly sand. Slopes are 0 to 2 percent. Annual precipitation is 8 to 10 inches. The frost-free period is 150 to 170 days.

Permeability is moderately rapid in the upper part of the profile and very rapid in the underlying very gravelly sand. Available water capacity is 2 to 4 inches. Typically, roots penetrate 30 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This soil is used for some irrigated row crops, small grain, hay, pasture, and wildlife habitat.

All crops respond to phosphorus fertilizer and to nitrogen. Organic matter content can be maintained or increased by returning all crop residue to the soil, by growing crops for green manure, and by including pasture and hay crops in the cropping system.

A suitable cropping system is alfalfa and grass for 4 to 6 years, corn for 1 year, and small grain for 1 year. Another suitable system is small grain for 2 years and potatoes for 1 year.

Irrigating this soil is difficult because water intake is very rapid and large streams cause erosion. Irrigation water can be applied by sprinklers, corrugations, or furrows: Sprinklers can be used for all crops. If a surface irrigation system is used, runs should be short and streams should be small to reduce water erosion. Some type of cover should be maintained through winter to reduce soil blowing.

Capability unit VIe-1

This capability unit consists of Frohman, Nyssa, and Virtue soils. These are well drained silt loams that have a hardpan. Slopes are 12 to 20 percent. Annual precipitation is 9 to 11 inches. The frost free period is 110 to 170 days.

Permeability is moderate or moderately slow above the hardpan. Available water capacity is 2 to 7 inches. Typically, roots penetrate 10 to 40 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to severe.

These soils are used for irrigated hay, pasture, and wildlife habitat.

These soils are suited to irrigated pasture and hay. They are not suited to cultivated crops, but small grain can be grown occasionally to reestablish plant cover, hay, or pasture. Crops respond well to nitrogen and phosphorus fertilizer. Permanent cover crops are needed to control erosion. All residue should be left on the ground to help maintain organic matter content.

Irrigation water can be applied by corrugations or sprinklers. Runs should be short and streams should be small on these soils because of the hazard of erosion. These soils are too steep and too shallow over a hardpan to be smoothed or leveled successfully.

Capability unit VIe-2

This capability unit consists of Nyssa, Owyhee, and Sagehill soils. These are well drained silt loams and fine sandy loams underlain by a hardpan or by laminated sediments. Slopes are 12 to 20 percent. Annual precipitation is 8 to 11 inches. The frost-free period is 150 to 170 days.

Permeability is moderate above the hardpan or the laminated sediments. Available water capacity is 4 to 12 inches. Typically, roots penetrate 20 to 40 inches in the soils underlain by a hardpan and 60 inches or more in the soils underlain by laminated sediments. Runoff is medium to rapid, and the hazard of erosion is moderate to severe.

These soils are used for irrigated hay, pasture, and wildlife habitat.

These soils are suited to irrigated pasture and hay. They are not suited to cultivated crops, but small grain can be grown occasionally to reestablish plant cover, hay, or pasture. Crops respond well to nitrogen and phosphorus fertilizer.

Irrigation water can be applied by corrugations or sprinklers. Runs should be short and streams should be small on these soils because of the hazard of erosion. These soils can be leveled, if necessary, with large cuts and fills.

Capability unit VIIIe-1

This capability unit consists of Duneland and Xeric Torriorthents. These are well drained to excessively drained soils and soil materials. Slopes are 0 to 60 percent. Annual precipitation is 8 to 11 inches The frost-free period is 150 to 170 days.

Permeability is very slow to very rapid. Available water capacity is 0 to 3 inches. Typically, roots penetrate only in fractures in the Torriorthents and 40 to 60 inches or more in Duneland. Runoff is very slow to very rapid, and the hazards of soil blowing and water erosion are slight to severe.

These soils or soil materials are used for wildlife habitat. They also provide a source of material for highway and other construction and a source of water.

Capability unit VIIIw-1

This capability unit consists of Riverwash. Drainage, materials, and vegetation are variable. Riverwash is subject to overflow when water level is high and is extremely droughty when water level is low. During each overflow, new deposits are received or some material is removed.

Riverwash is used for wildlife habitat and recreation.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the soil is not suited to the crop or the crop is not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Wildlife habitat

Fishing in the survey area is mostly for warm water fish such as crappie, smallmouth and largemouth bass, catfish, and a few rainbow trout in special areas. The impoundment waters are stocked with trout, crappie, and bass.

Hunting in the survey area is good for migrating waterfowl and for game birds such as ring-necked pheasant, California quail, and some Hungarian partridge. The many irrigation canals, ditches, and small ponds scattered throughout the area provide nesting and resting spots for waterfowl. Grain stubble fields, harvested field corn, and standing corn attract many migratory birds in fall.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 3, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of very *poor* means that restrictions for the element of wildlife habitat or kind of habitat are very severe and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include antelope, white-tailed deer, desert mule deer, sage grouse, meadowlark, and lark bunting.

Recreation

The soils of the survey area are rated in table 4 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 4 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 5, and interpretations for dwellings without basements and for local roads and streets, given in table 6.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walling, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas *of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.*

The information is presented mainly in tables. Table 6 shows, for each kind of soil, the degree and kind of limitations for building site development; table 5, for sanitary facilities; and table 8, for water management. Table 7 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables,, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sits for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 5 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* and *poor*, which mean about the same as *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil.. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 5 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

If it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 6. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specked use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 6 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope; and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 6 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 7 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction material. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 9 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low frost action potential, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 9.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils or very firm clayey soils; soils that have suitable layers less than 8 inches thick; soils that have large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 8 the site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties.

They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 9 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 9 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Descriptions of the soils."

Texture is described in table 9 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (2, 5) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (1, 5).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes-eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7 are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Also in table 9 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also-used as indicators in making general predictions of soil behavior. Range in liquid limit and in plasticity index is estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 10 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field-particularly soil structure, porosity, and gradation or texture-that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems. It is commonly expressed as inches of water per inch of soil.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence; the salinity of individual fields can differ greatly from the value given in table 10. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal' and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land, use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 11 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 11 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Cemented pans are hard subsurface layers, within a depth of 5 or 6 feet, that are strongly compacted (indurated). Such pans cause difficulty in excavation. The hardness of pans is similar to that of bedrock. A rippable pan can be excavated, but a hard pan generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Formation, morphology, and classification of the soils

In this section, the factors that have affected the formation and composition of the soils in the survey area are described, and some important morphological features are discussed. The last part of the section deals with the classification of the soils of the survey area.

Formation of the soils

Soil is formed by weathering and other processes that act on parent material. The characteristics of the soil at any given point depend mainly on five factors: parent material, climate, plants and animals, relief, and time.

The active factors that gradually form a soil from parent material are climate and plant and animal life. Relief strongly influences natural drainage, aeration, runoff, erosion, and exposure to sun and wind and therefore influences the effectiveness of the active soil-forming factors. Generally, soil formation is complex. Each factor interacts with others, and slowly but constantly they bring about changes. A soil passes slowly through stages that can be considered as youth, maturity, and old age. Therefore, the character and thickness of a soil depend on the intensity of the soil-forming processes, the length of time during which the various processes have acted, and the resistance of the parent material to change.

At any stage in its history, a soil may be affected by mechanical agencies and use by man. The original surface layer may be wholly or partly removed by erosion and the material beneath be exposed. A new surface layer then begins to form. Whether or not erosion benefits the growth of plants depends on the rate of erosion and on the supply of plant nutrients available in the new surface layer. Normal geologic erosion can benefit the soil; accelerated erosion caused by improper use of the land can severely limit the use of the land for many years. Grading, shaping, and leveling of land by man rearrange the soil horizons and interrupt the effects of soil-forming factors. Irrigating a soil when it normally is dry has the effect of placing the soil in a different climatic zone. Drainage by ditch or tile drains counteracts the effects of relief and climate, thereby changing the relationship among the soil-forming factors. Applying amendments and chemicals affects the chemical composition of the soil and the plant and animal life.

The five soil-forming factors are discussed in the paragraphs that follow.

Climate

The effects of climate are expressed both directly in soil formation and indirectly through control of the kinds and amount of native vegetation. The climate of this area is mainly semiarid. Most of the annual precipitation falls in winter.

In this survey area temperature in winter is so low that the soils are frozen for long periods. During these periods many processes of soil formation completely stop. The upper few inches of the soil is frozen for some period during winter, and daily freezing and thawing are common. Summer temperatures are hot. Average annual air temperature is normally 47 degrees to 54 degrees F.

Under natural conditions, the amount and distribution of precipitation are such that most soils become thoroughly dry in some part of the solum for at least 60 days in most years. Average annual precipitation is 8 to 11 inches. The precipitation is concentrated mainly between October and June. Precipitation is spotty and scant in summer, and it is often lost to evaporation. Rainfall is insufficient to leach the soils strongly.

Organisms

The natural vegetation on well drained soils is mainly Thurber needlegrass, Sandberg bluegrass, big sagebrush, hopsage, and saltbush. These soils have an A horizon that is about 4 to 8 inches thick, and they have about 1 percent organic matter.

Soils that are not well drained have different native plants from the plants common on well drained soils. On the flood plains of streams, grasses, big sagebrush, and greasewood grow in various combinations.

Animals and insects that burrow in the soil also influence the kinds of soil that form, but probably have less influence than plants on the soils of this survey area.

Gopher activity is common in silty or loamy soils that are relatively free of stones.

Parent material

Parent material is the unconsolidated mass in which a soil forms. It determines the chemical and mineralogical composition of the soil. The soils in this area formed in fluvial and lacustrine sediments and in eolian materials.

Eolian materials are of two kinds: sands near the flood plains of the Snake River and calcareous loess on the higher terraces. Feltham soils formed in sandy materials, and Greenleaf, Malheur, and Virtue soils formed in silty loess.

Fluvial sediments consist of unconsolidated clay, silt, sand, and gravel mixed in varying proportions. These materials were derived mostly from rhyolite, quartz monzonite, diorite, and arkose; they also contain some basalt. The most recent deposits are along flood plains and on very low terraces. Older sediments are on terraces above the flood plains. The older sediments consist of clay, silt, sand, and gravel and contain some limy cementing material, mostly, caliche. The soils that formed in the older sediments generally are well drained, have a moderately developed profile, and are loess in the upper part. Chilcott and Frohman soils formed in this type of material. Soils that formed in the recent sediments generally have a weakly developed profile, are medium textured or moderately coarse textured, and are somewhat poorly drained. Baldock and Umapine soils formed in recent fluvial sediments.

Recent silty lacustrine sediments that have a loess mantle occur on medium and low terraces near Adrian, Nyssa, Ontario, and Weiser Annex. Greenleaf, Nyssa, and Owyhee soils formed in these sediments. These soils are well drained and silty, and they have a weakly to moderately developed profile.

Diatomite and volcanic ash occur in the Malheur River drainage basin near Harper. These diatomaceous and ashy materials have accumulated in the Bully soils near Harper.

Relief

The relief, or topography, of the land influences the genesis of soils through its effect on drainage, erosion, plant cover, and soil temperature. Most of the survey area consists of nearly level to gently sloping soils on terraces. Alluvial fans, low terraces, and bottom lands occur near drainageways, streams, and rivers.

Relief influences the movement of water across or through the soil profile. Water that moves across a soil tends to erode it. Water that moves through a soil leaches plant material and causes these materials to accumulate in lower horizons of the profile. In low wet areas, where Baldock, Kiesel, Stanfield, and Urnapine soils occur, water and soluble salts from higher areas accumulate in the profile. On terraces and uplands, where level to gently sloping Chilcott, Greenleaf, Malheur, and Virtue soils occur, most of the natural precipitation moves downward through the profile, transferring soluble salts and carbonates to lower horizons and causing silicate clay to accumulate in the Bt horizon.

Through erosion and deposition, deep alluvium consisting of material from higher soils accumulated along bottom lands and drainageways. Harana and Powder soils formed in this deep alluvium.

Time

Soils range from young to relatively old according to length of time the parent material has been in place and has been exposed to the factors of soil formation.

Older soils have well defined horizons and commonly occur on the oldest and most stable land formations. Among these soils are those of the Chilcott, Malheur, and Virtue series. These soils have a strong, clayey Bt horizon and a strongly cemented or indurated hardpan.

Young soils generally occur on unstable land forms where new soil material, such as alluvium, is continually added or where soil material is continually removed through water erosion or soil blowing. Young soils of the Garbutt, Harana, Powder, and Turbyfill series formed near streams, in drainageways, or on alluvial fans where they regularly receive fresh deposits of parent material. Other soils, such as those of the Feltham and Qunicy series, are young because they formed in sand dunes or eolian material that has stabilized only recently. In steep, barren areas, the rate of erosion exceeds the rate of soil development, and only parent material suitable for soil formation is present.

Processes of soil formation

Most of the soils in the survey area have a weakly developed or only moderately developed profile. Profile development is a result of accumulation of organic matter, leaching of soluble salts and carbonates, formation of silicate clay from primary minerals, translocation of carbonates, silicate clay, and particles from one horizon to another, accumulation of salts and alkali, chemical change and transfer of iron, and translocation and concentration of silicates or silica in a cemented layer. These factors are discussed in the following paragraphs.

Accumulation of organic matter.-Some organic matter has accumulated in the upper 15 inches of all of the soils. The amount varies. It is about 0.5 percent in Frohman, Kiesel, and Malheur soils; 1.0 to 1.5 percent in Nyssa, Owyhee, and Virtue soils; and 1.5 to 3.0 percent in Baldock and Harana soils. Soils in very dry areas, such as those of the Garbutt and Turbyfill series, have a thin Al horizon only beneath and within several inches of the naturally sparse vegetation and the Cl horizon is at the surface in about 60 percent of the area.

Leaching of carbonates and salts.-Salts and carbonates have been leached in well drained soils, and in most cases this has been the most important process in horizon differentiation: In only a few soils have all soluble salts and carbonates been leached from the profile. In soils that have a weakly developed profile, such as those of the Nyssa series, carbonates have been leached from the upper 10 to 16 inches and a moderate or strong concentration of carbonates occurs at a depth of 20 to 24 inches. In soils that have a strongly developed profile, such as those of the Chilcott and Virtue series, the Al horizon is neutral or slightly alkaline and carbonates are concentrated in strongly calcareous lower horizons.

Formation of silicate clay.-Following the removal of carbonates, which retard the disintegration of primary silicates, silicate clay minerals develop more rapidly. Silicate clay that formed from primary minerals in the presence of alkali and alkaline earths, especially potassium and magnesium, is predominantly illite or montmorillonite. The presence of calcium favors the formation of montmorillonite and inhibits the formation of kaolinite (3). Although montmorillonite is the dominant clay mineral in mature soils in the area, other clay minerals, including illite and to a lesser extent kaolinite, occur in many of the soils. The kaolinite was present in parent materials that were transported from other climatic zones or that accumulated in the shallow sediments of ancient Payette Lake.

Translocation of silicate clay.-In many of the soils of the area, clay has been removed from the A horizon and has accumulated in a Bt horizon. This is true of all soils that have a textured B horizon. It is most evident in soils that have a moderately fine textured or fine textured B2t horizon, such as those of the Chilcott, Greenleaf, Malheur, and Virtue series. In some soils, the amount of silicate clay that is formed, translocated, and accumulated is not sufficient to form a textural B horizon. In these soils, most carbonates and salts have been leached from the upper horizons, blocky or prismatic structure has formed below the A horizon, and only a very small amount of clay has accumulated. Under these conditions, a cambic horizon forms where not enough clay has accumulated to form a Bt horizon. Owyhee soils have a cambic horizon.

Accumulation of salts and alkali.-Saline-alkali soils form where ground water moves upward through the profile. Soluble salts and carbonates move upward with the water and are deposited in the upper horizons when water evaporates. Examples of saline-alkali soils are in the Stanfield, Otoole, and Umapine series.

Transfer of iron.-Where reduced under conditions of poor aeration, iron usually becomes mobile. In well drained soils it may move out of the soil in ground water. In poorly drained soils it remains in the horizon where it originated or moves only to a nearby horizon. Alternate wetting and drying of these horizons causes part of this iron to reoxidize and to congregate as mottles, such as the distinct reddish brown or brown mottles in Baldock soils. However, in poorly drained soils in which salts, carbonates, and exchangeable sodium have .accumulated, the iron is relatively insoluble. Because the soils are alkaline, the iron does not move or congregate. For example, in Otoole, Stanfield, and Umapine soils, mottling is less than normal for soils that are as wet and as shallow to ground water as these soils are.

Formation of cemented layers.-Translocated silicates or silica and carbonates combine to form weakly cemented nodules of soil material in weakly developed profiles and strongly cemented durinodes and duripans in moderately and strongly developed profiles. In well drained soils of the area, nodules of soil material occur in the horizon that has the maximum accumulation of carbonates. In places, nodules also occur in adjacent horizons. The nodules make up very little to more than 50 percent, by volume, of the horizon in which they occur. Weakly cemented nodules slake when wet. Strongly cemented nodules remain firm when soaked alternately in concentrated sodium hydroxide and hydrochloric acid. Most of the nodules consist of soil material that filled holes occupied by cicada pupae (4). The walls of the holes were partly solidified by compaction and were weakly cemented by organic secretions. As carbonates and silicates accumulate, the horizon became more strongly cemented. This horizon is weakly cemented in Owyhee soils and is moderately cemented in Nyssa soils. In Chilcott and Virtue soils it forms a strongly, cemented or indurated duripan.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (7).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 12, the soils of the survey area are classed according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in sol. An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquents (*Hapl*, meaning simple horizons, plus *aquent*, the suborder of Entisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three kinds of subgroup: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great group; and the extragrades, which have some properties that are representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective Typic identifies the subgroup that is thought to typify the great group. An example is Typic Haplaquents.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, nonacid, mesic, Typic Haplaquents.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

General nature of the area

This section discusses the settlement and the relief and drainage of the area. It also describes the climate.

Settlement

Hudson's Bay trappers and various mountain men traveled through this area in 1812. The Oregon Trail was established through Vale in 1843 and this was the start of settlement in the survey area. Farming was first restricted to land adjacent to the streams. This land was irrigated with water lifted by waterwheels or intercepted by small diversion structures. Improvements came with time and need; companies and projects were formed. The Nevada Ditch was one of the first major projects. It diverted water from the Malheur River just east of Vale. The Warm Springs Irrigation District was formed in 1916, and an arch structure dam was built on the Middle Fork of the Malheur River above Riverside in 1919. The Vale-Oregon Project, constructed by the Bureau of Reclamation, took over the Warm Springs Dam and did additional work, on it. In 1938 the Bureau constructed the Agency Dam, which impounds water on the North Fork of the Malheur River 15 miles upstream from Juntura. Bully Creek Dam was constructed in 1963. On the Owyhee River, water was diverted into ditches or lifted by waterwheels until the Bureau of Reclamation constructed the Owyhee Dam. The Owyhee Dam and canal systems was started in 1928 and the first water was delivered in 1935. These combined projects provide water for more than 200,000 acres of land.

Industries connected with agriculture have developed throughout the area: Commercial plants in Nyssa and Ontario process sugar beets, potatoes, and corn. Marketing facilities for potatoes, onions, and grain are located in all areas. Alfalfa hay is grown in rotation on some of the steeper soils and helps to maintain some of the beef industry in Malheur County. Climatic conditions are such that specialty crops can be and are raised. Seed is produced for alfalfa, carrots, lettuce, radishes, and onions. Mint is raised for oil. Hops are grown on a small acreage. Feed lots for beef production have been increasing, and corn for silage is grown in all parts of the area. There is room for additional industries in the area, but most of the water potential has been reached.

Relief and drainage

The survey area includes land along parts of the Snake, Malheur, and Owyhee Rivers-the alluvial bottom lands and adjacent stream and lake terraces up to the elevation of the Owyhee Main Canal, which is about 2,600 feet at Mitchell Butte on the south and 2,400 feet on the north end above Dead Ox Flat. These terraces are mostly level but are dissected with many small and large drainageways with gently sloping to very steep escarpments.

In general, age and development of soils in this area are closely related to height above and distance from the three major rivers that flow through or bound the area. The soils nearest the rivers show the least profile development but may be mottled or show effects of salts and alkali. As height increases to the terrace tops, so does the profile development and cementation of a hardpan. The least soil depth and most strongly developed hardpans occur at the highest elevations along the Owyhee Main Canal.

Distribution of sand and clay in soils has a pattern from south to north. The majority of soils with the most clay are on the north end of the survey area.

The Snake River flows north from where it enters the county from Idaho and swings back east before turning north and forming the common boundary between Oregon and Idaho. The Malheur River flows from west to east and picks up the waters of Bully and Willow Creeks at Vale. The Owyhee River drains from the south and flows through the area only a short distance before it empties into the Snake River. These three major rivers and their tributaries supply water for most of the irrigation projects within the area's canal systems.

Climate

In Malheur County summer is hot, especially at lower elevations, and winter is cold. Precipitation is normally light at lower elevations during all months of the year, and the soils are mainly used for range. At higher elevations, precipitation is much greater and snow accumulates to considerable depths. Much of the snowmelt irrigates crops in nearby valleys.

Table 13 gives data on temperature and precipitation for the survey area, as recorded at Malheur Branch Experiment Station for the period 1951 to 1974. Table 14 shows probable dates of the first freeze in fall and the last freeze in spring. Table 15 provides data on length of the growing season.

In winter the average temperature is 31 degrees F, and the average daily minimum temperature is 24 degrees. The lowest temperature on record, which occurred at Malheur Branch Experiment Station on January 23, 1962, is -26 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 88 degrees. The highest recorded temperature, which occurred on August 4, 1961, is 108 degrees.

Growing degree days, shown in table 13, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 4 inches, or 40 percent, usually falls in April through September, which includes the growing season for most crops. In 2 year out of 10, the rainfall in April through September is less than 3 inches. The heaviest 1-day rainfall during the period of record was 1.52 inches at Malheur Branch Experiment Station on September 14, 1959. About 14 thunderstorms occur each year, 9 in summer.

Average seasonal snowfall is 19 inches. The greatest snow depth at any one time during the period of record was 9 inches. On the average, 15 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 40 percent. Humidity is higher at night, and the average at dawn is about 60 percent. The prevailing wind is from the southeast. Average windspeed is highest, 10 miles per hour, in March.

Every few years a blizzard strikes the survey area with high winds and much drifting snow. Even at lower elevations, snow remains on the ground for many weeks and livestock suffer.

Climatic data in this section were specially prepared for the Soil Conservation Service by the National Climatic Center, Asheville, North Carolina.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as-

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Badland. Steep or very steep, commonly nonstony barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are-

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky. -When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains tinder very slight pressure.

Cemented.-Hard; little affected by moistening.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained. -Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown Very poorly drained soils are commonly level or depressed and are frequently ponded Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fine, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; rare that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and long if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.-An organic layer, fresh arid decaying plant residue, at the surface of a mineral soil.

A horizon.-The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon

A2 horizon.-A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are-

Border.-Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.-Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.-Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.-Water is sprayed over the soil surface through pipes or nozzles from a pressure system

Subirrigation.-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.-Water, released at high points, is allowed to flow onto an area without controlled distribution.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-*few, common, and many; size-fine, medium, and coarse; and contrast-faint, distinct, and prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 02 inch); *medium*, from 5 to 15 millimeters (about 02 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 020 inch), moderately slow (02 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Piping. Moving water forma subsurface tunnels or pipelike cavities *in* the soil.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; contains harmful salts and is strongly alkaline; or contains harmful salts and exchangeable sodium and is very strongly alkaline. The salts, exchangeable sodium, and alkaline reaction are in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the speed use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual rninenal particles that range in diameter from the upper linut of clay (0.002-millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse;' .`fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Illustrations

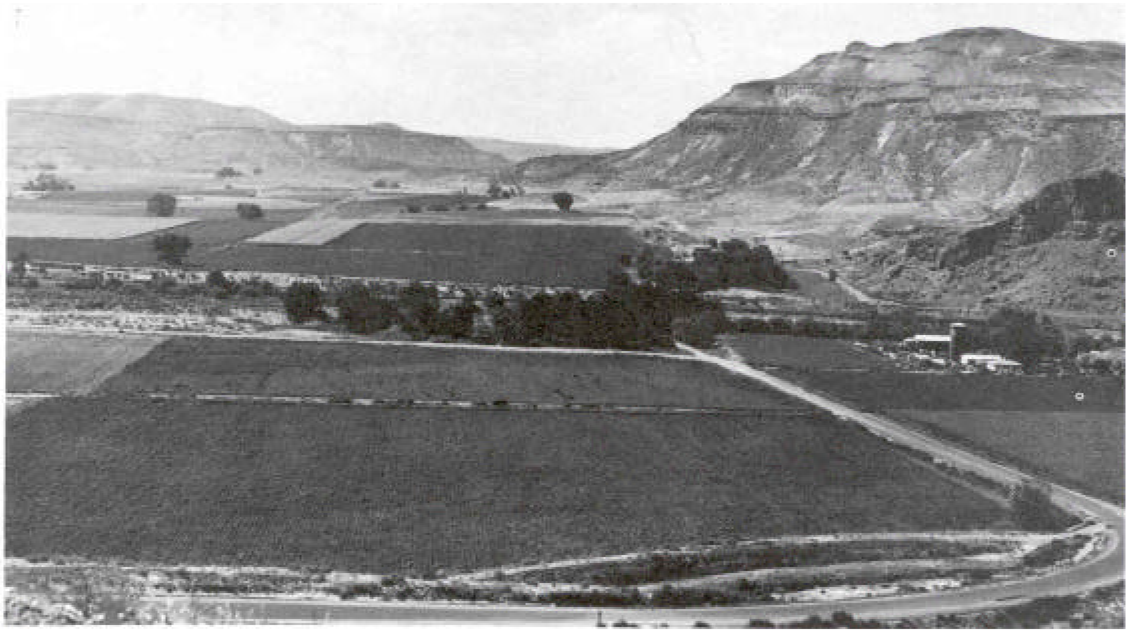

Figure 1.-Kimberly fine sandy loam on bottom land in foreground. Slopes are 0 to 2 percent. Crops are irrigated corn and potatoes. In background is a Nyssa silt loam in irrigated alfalfa and corn.

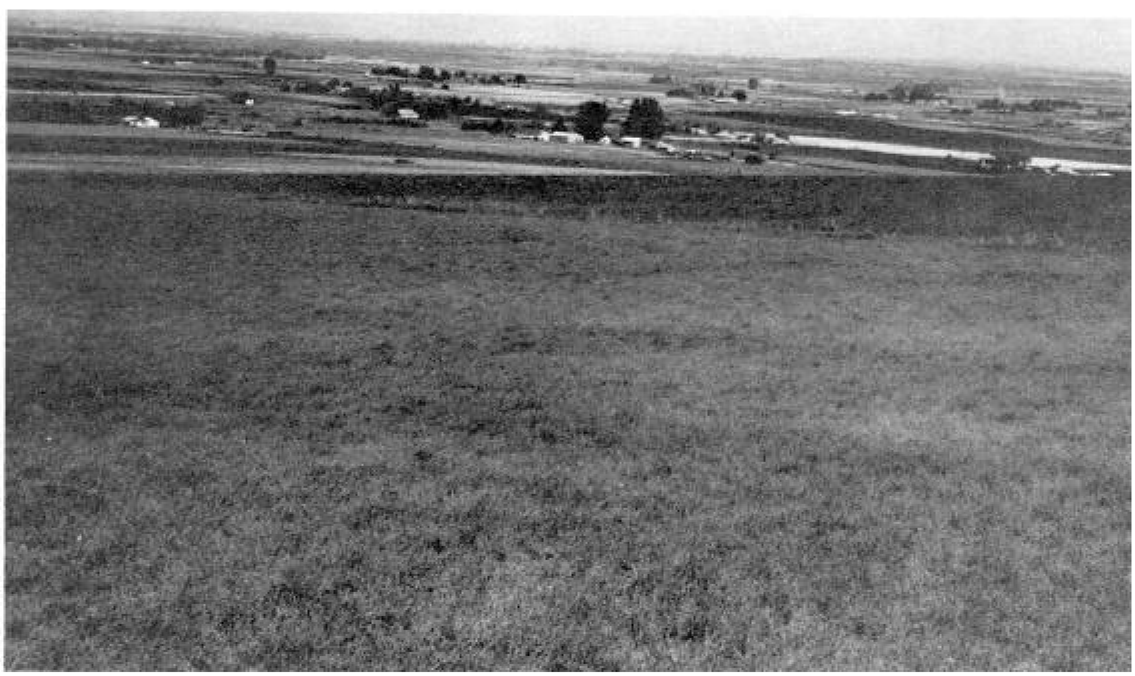

Figure 2.-Irrigated alfalfa for hay and seed in an area of Owyhee and Nyssa soils in foreground.

Figure 3.-Irrigated sugar beets, corn, and small grain on Powder silt loam
Slopes are 0 to 2 percent.

Figure 4-Irrigation of onions with siphons from a concrete-lined ditch on Owyhee silt loam,
0 to 2 percent slopes.

Figure 5.-Irrigation of sugar beets from underground pipeline and gated pipe on Nyssa-Malheur silt loams, 2 to 5 percent slopes.

Figure 6.-Deep plowing to a depth of 36 to 40 inches of Nyssa-Malheur silt loams, 0 to 2 percent slopes Deep plowing mixes the subsoil and the surface layer of the Malheur soil, improving structure, tilth, and water intake rate.